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Recent Scientific and Technical Books	Supp. II

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INTERNATIONAL CONTROL OF ATOMIC ENERGY

THE sober, and somewhat sombre, review of the proposals for the international control of atomic energy, and the appraisal of the present position, which Dr. J. R. Oppenheimer, chairman of the Advisory Committee of the Atomic Energy Commission of the United States, contributes to the current issue of *Foreign Affairs*, appeared appropriately just when President Truman's Air Policy Commission had warned the United States that within five years foreign countries would almost certainly possess atomic weapons in quantity and would probably also have in mass production effective long-range guided missiles. Dr. Oppenheimer's review should receive close study, not merely by those directly interested, but also by scientific workers generally, on its own intrinsic merits. Apart from Dr. Oppenheimer's authority, it is a most valuable indication of the trend of opinion which has led to the specific recommendations of the Air Policy Commission, and as such assists materially in appraising their significance.

Dr. Oppenheimer attempts to present, briefly but objectively, some of the sources of United States policy, and the formulation of that policy in the context of contemporary events. His article is also useful in assisting those outside the United States to estimate not merely the sound and durable elements in that policy, but also the reasons for its present lack of success. He does not enter deeply into political considerations, though they are not ignored; but the scientific and technical aspects are presented in balance with the political aspects in a way that should facilitate realistic discussion.

Early in this article, Dr. Oppenheimer makes the important point that the advantages which could come from the exploitation of atomic energy do not appear to be of such a character that they are likely to make a short-term contribution to the economic or technical well-being of mankind. It was clear two years ago that, although the generation of useful power from atomic sources was possible and that decisive progress in favourable circumstances was probable within a decade, the question of the utility of this power, the scale on which it could be made available, and the costs and general economic values would take a long time to answer. Intensive development and exploration are required; no evaluation, in Dr. Oppenheimer's view, could justify regarding atomic power as likely to provide immediate economic aid on a world-wide scale, or give its development the urgency of the control of atomic armaments. Similarly, he reminds us that the other form of application, involving the use of tracer materials, radioactive species, and radiations for science, the practical arts, technology and medicine, depends in the first instance upon the skilful development of chemical, physical and biological techniques—a development which under the best conditions is a gradual and continuing one.

It follows from this that the development of atomic energy for such peaceful purposes cannot present a direct appeal to the weary, hungry, almost desperate peoples of a war-ravaged world. Despite its challenge to the interests of technical men, and also to the vision of the statesmen concerned with long-term projects for human welfare, honesty compels us to regard such development as falling within the category of long-term projects, the development and exploration of which may have to be deferred until immediate needs have been met. That view lends some support to proposals which have already been advanced elsewhere, for example, by Mr. Lewis Mumford in "Programme for Survival", that we should forgo the use of atomic power until the world is better prepared for it.

Even if it is clear that mankind would lose little in the next few decades by such renunciation, it still remains to be seen whether it is practicable, even if it is wise, to postpone consideration of the control of large-scale power production. Here it should be noted, as Dr. Oppenheimer reminds us, that the development of atomic power cannot be separated from the technological development essential and largely sufficient for the manufacture of atomic weapons; and again, neither the development of power nor the effective and widespread use of the new tools of research and technology can prosper fully without a degree of freedom in regard to the technical realities difficult to reconcile with the traditional requirements of military security about the development of weapons of war.

These views have been overshadowed in most discussions by preoccupation with the control of atomic energy to the extent required to prevent its use for destructive purposes, and more especially with those considerations which derive from the nature of atomic armament. The main concern of the latter part of Dr. Oppenheimer's paper is to redress the balance, and to give to those arguments derived from the political climate of the post-war world the preponderance in determining policy which he considers they should have. Indeed, he contends that our excessive concern with the arguments based on the nature of atomic armament are the main cause of estrangement and misunderstanding with the U.S.S.R., and that relegation of problems of atomic energy to discussions with the United Nations has prejudiced the chances of any genuine international intellectual co-operation.

Dr. Oppenheimer recognizes fairly enough that during the Second World War the fabric of civilized life was worn so thin in Europe that there is the gravest danger that it will not hold. He admits, too, that the question of the future of atomic energy presents itself in one main constructive context: What can be done with this development to make it an instrument for the preservation of peace and for bringing about those altered relations between the sovereign nations, on the basis of which there is some reason to hope that peace can be preserved? He argues, however, that although this may have been the question in principle, a far more concrete and immediate problem faces the world, namely, whether the co-operative control and development of atomic energy might not play a unique and decisive part in establishing co-operation between the U.S.S.R. and the United States.

For all its frustrations and disappointments, the Atomic Energy Commission of the United Nations, notwithstanding the limitations under which it has worked, has proved the vitality of the basic idea of security through international co-operation. Dr. Oppenheimer does not examine the question whether the United States, Great Britain, Canada, and those other nations that are prepared to accept the necessary sacrifice of national sovereignty involved in a control system with its essential international inspectorate, should go ahead and demonstrate in a limited field the feasibility of such a scheme. He rightly observes that collaboration in the field of atomic energy cannot be entirely separated from collaboration in other fields; and although he does not suggest that it would necessarily have succeeded, he argues that an attempt should have been made to influence the U.S.S.R. at a higher level and to make the heads of the Soviet Union, in part at least, party to the effort at control.

That effort has not been made, and only the historian can pronounce upon the probability of its success. Meanwhile, we have to face the fact that the most unexceptional formulation of principles set forth in the report "International Control of Atomic Energy: Growth of a Policy" (Washington: Department of State Publications, 2702; 1947) confronts the evasion of the very bases for co-operation between the United States and the Soviet Union. Episode after episode in the last two years has emphasized their deep conflicts of interest, the apparently mutual repugnance of their ways of life, the non-co-operativeness of the Soviet Union and its apparent conviction of the inevitability both of the decay of American democracy and of conflict.

In such an atmosphere there can be little hope that measures of international control less radical than those already proposed by the United States will be either adequate or acceptable. Even in a situation less tense, there would have been considerable difficulties in reconciling particular national security, custom and advantage with an overall international scheme for security. In the present juncture, formal renunciation of atomic armament and some concession with regard to access to atomic facilities on the part of international inspectors is no more likely to commend itself as adequate to Great Britain and other nations than to the United States or Canada. Dr. Oppenheimer himself sees little hope except in a profound change in the whole orientation of Soviet policy, and a corresponding reorientation of American policy, even in matters far from atomic energy; though he urges that those who work for the establishment of peace and who wish to see atomic energy contribute whatever is possible to that end should maintain all that is sound in the early hopes and work for their eventual realization.

One road to peace may be through a limited scheme of control applying to the Western democracies. This may give time for the creation by writers, artists, scientific workers, teachers, and travellers of a widening field in which there is a common human bond and understanding between the diverse peoples of the world.

In this connexion the discussions now proceeding on an international declaration on human rights may be of significance. The British delegation, for example, is in favour of a covenant containing legally enforceable obligations, and in the Foreign Office draft Bill of Human Rights the obligations deemed acceptable are limited to those guaranteeing the existing common law rights of Englishmen. The accompanying memorandum argues that the right of all persons to work, to education, to social security and similar social and economic rights cannot "by their nature" be defined in the form of legal obligations for States. It is, however, precisely these obligations which the Slav bloc might conceivably accept as in its view the indispensable guarantees of true political freedom. Without suggesting that the cause of peace will be furthered by any slackening of the effort to spread Western ideals of political freedom, it may well be, as Mr. Bryan King suggests in *The Economist*, that an international treaty is not the right medium for their propagation; such an instrument should afford rather the opportunity to establish or affirm common aims which will help to dispel mistrust and open the way to better understanding. Whatever views may be held as to the practicability or value of an international affirmation of faith in fundamental human rights and in the dignity and value of the human person, there can be no question as to the importance of not allowing either an idealistic or a legalistic point of view to accentuate differences and place fresh obstacles in the way of international understanding.

In this context it may be recalled that the Atomic Scientists' Association, although limiting its full membership to scientific workers with specialist knowledge of atomic energy, seeks to enrol the support of a large body of associate members, both scientific and lay, to broaden the activities and to increase the effectiveness of the Association. Such support is clearly invaluable and indeed essential for the expansion of the publicity activities of the Association. It should also counteract any tendency to approach the problems of atomic energy from too narrow an angle, and help to bring those intimately concerned with atomic physics into closer touch with other men of science, and the ordinary citizens alive to the larger issues at stake.

The report of the Air Policy Commission of President Truman provides a first-rate example of how much depends on the existence of an informed body of responsible opinion. The specific recommendations of the report are indeed less important than the affirmation by this body of distinguished private citizens of their belief that "the United States will be secure in an absolute sense only if the institution of war itself is abolished under a regime of law. World peace and the security of the United States are now the same thing." Even the most optimistic view of the record of the United Nations affords no assurance that that Organisation will develop in time the necessary authority to prevent another war.

It will be noted that this blunt report and the hardening of opinion which it tokens has something in common with Dr. Oppenheimer's conclusions and with the trend of thought elsewhere. There can now be little to hope from another examination of the current Russian proposals, and the Atomic Energy Commission has held only one ineffective meeting since its second report was made to the Security Council in September. The question of atomic energy and its control and development is now merging into the larger issues of which it forms a part; and when the Air Policy Commission expresses its belief that a strong America will be a force for peace, it is giving expression to views which are widely held and responsibly endorsed among the Western democracies. But the nations joining in any limited scheme of collective security, including the control of atomic energy as one essential element, must make clear what they regard as essential interests and make known resolutely and unambiguously where they will make a stand; and at the same time, they must use every means available to promote understanding and good will, and to demonstrate afresh the inherent greatness and resilience of Western civilization and its tradition and heritage of human individuality and freedom. Demonstration of the moral, spiritual and economic strength of Western Europe may in due course prepare the way for the adherence of the U.S.S.R. to a system of collective security the practicability and soundness of which has been made evident.

CONTROLLING THE STAFF OF LIFE

Modern Cereal Chemistry

By Dr. D. W. Kent-Jones and Dr. A. J. Amos. Fourth edition. Pp. vii + 651. (Liverpool: Northern Publishing Co., Ltd., 1947.) 50*s*. net.

IT were a work of sheer supererogation to recommend "Kent-Jones and Amos" to cereal chemists or to any of those concerned with the technical side of the milling and baking industries. They will all have this new (fourth) edition, if not on their shelves then certainly on order—or on loan! Indeed, there is much to be said for the definition of cereal chemist as "a graduate in chemistry whose work makes it essential for him to possess Kent-Jones and Amos and to consult it at least once a day!" To avoid gilding the lily or piling Pelion on Ossa or whatever may be the appropriate metaphor, I propose as a non-cereal chemist to consider in this review how far "Modern Cereal Chemistry" may be of value as a permanent companion of chemists practising in other branches of the food and allied industries. To do this it will be simplest to take a look at each chapter or group of chapters separately.

We begin, then, by considering the "Composition of Wheat and Products of Milling", which contains

photographs of two delightful pieces of Egyptian statuary, dated 3300 B.C. The authors' subject has indeed a history. Not only have we in this chapter a detailed discussion of the proximate analysis of wheat and its milling fractions, but the chemistry of the carbohydrate, protein and fat constituents is also exhaustively expounded. A chapter like this should be of value and interest to any chemist who has ever to handle wheat or its milling products, even if only as a direct consumer of the grain or an indirect consumer of its milling products by way of the domestic hen's eggs. It is worth noting that neither in this chapter nor in any part of this book do the authors for a moment connive at that distressing term 'wheat berry', which has somehow crept into scientific jargon and is curiously difficult to exorcise. The wheat grain, as they point out on page 1, is a seed.

Chapter 2, on "Principal Wheats of the World", has an obvious interest for botanist and geneticist; it is also aimed at the pestologist, for it contains descriptions of all the leading wheat diseases due to infection or infestation and to methods of getting rid of them. Chapter 3, on "Barley", includes consideration of malt, but maintains a discreet silence on the main technological problem connected with the use of malted barley, for reasons, no doubt, of space rather than of personal predilection. Brewing has, in any event, many excellent text-books of its own already. Chapter 4 gives in admirably condensed form summarized data about four more cereals—rye, oats, maize and rice—as well as about two non-cereal sources of carbohydrate of world-wide importance—soya and the potato. Chapters 3 and 4 must obviously be immediately accessible to any chemist who has frequently or regularly to handle any of these food plants or their products, whether they be destined for human consumption, for stock-feeding or for industrial exploitation.

The next three chapters bring us directly into the field of milling technology and deal respectively with "Some Physico-Chemical Aspects of Flour", "Flour Strength" and "Conditioning and the Effect of Heat on Wheat and Flour". They may well be considered along with certain later chapters—"The Technique and the Chemistry of the Baking Process" (9), "Bleaching and Flour Improvers" (10) and perhaps also "Dough Testing Apparatus" (11). It is interesting to those who maintain the impossibility of separating 'pure' and 'applied' science to note how many problems in fundamental biochemistry crop up during the discussion of such mundane matters as the baking qualities of flour, which leads to a condensed but admirable general exposition of *p*H and *r*H, with incidental references to the electronic theory of atomic structure. The intensity of research effort that has gone into many of the basic phenomena underlying industrial practice is well exemplified by a passage in Chapter 10 where the authors, discussing the action of flour improvers, refer to the work of Jørgensen on the use of potassium bromate. On this extremely specialized problem the Danish worker has produced a volume of 434 pages—with a bibliography of no less than 10 pages and 218 references*. Kent-Jones and Amos write of this book that the author "has certainly put up a good case for his theory and has replied to a number of his critics". It would ill become a non-expert to add to this masterly comment.

* Studies on the Nature of the Bromate Effect. By Dr. Holger Jørgensen. Pp. 435. (Copenhagen: Einar Munksgaard; London: Oxford University Press, 1945.) 40 Danish crowns; 40*s*.

Chapter 8, on the "Composition of Milled Products", is a logical extension of Chapter 1. It is packed with tabular matter and carries with it the conviction that nothing known about the chemical make-up of commercial wheat products has passed through the authors' fine-meshed bibliographic bolting-cloth. Many of the data included are based on their own work, which the bibliography (42 pages at the end of the book) shows to go back at least to 1924. "Use of Wheat and Flour for Special Purposes" (Chapter 12) covers such subjects as self-raising flour and baking powder, biscuit manufacture, confectionery, macaroni, dog biscuits and alcohol production.

Two of the longest chapters, as is only right, are those concerned with "Nutritive Value of Cereals" (12) and "Cereal and Balanced Rations for Live-stock" (13). For certain obvious reasons I will not comment on these, except to say that the authors, though convinced supporters of a 'white bread' policy, preferably with enrichment, state the case of their opponents who favour the use of long-extraction flour with a fairness and objectivity that might well be an example to some of those opponents. These two chapters, depending as they do for their validity on accurate knowledge about the nutrient analysis of cereals and their products, extend the earlier chapters (1 and 8), and justify the meticulous details of the final two chapters on methods of analysis. These are "General Analytical Procedure for Cereals" (17) and "Assay of Vitamin Content of Cereals and Cereal Products". Here, surely, is the last word (at January 1947) on how to measure the individual compounds present in the most important of all man's foods.

There remains space only to mention the titles of Chapters 15 and 16, "The Microbiology of Cereals" and "Moisture in Cereals and Cereal Products", and thirty pages of tabular appendixes, giving figures on such diverse subjects as the atomic weights of the elements, relative humidities and compositions of ingredients used in common feeding stuffs. Could not future editions include a table of the manifold, and often mysterious, measures used in the milling and baking industries?

Finally there is, of course, a thoroughly adequate index (31 pages) to end a book for which, and for the knowledge, energy and enthusiasm that have gone to the writing and rewriting of it, there is only one word—prodigious!

A. L. BACHARACH

SERVO-MECHANISM FUNDAMENTALS

Servo-mechanism Fundamentals

By Henri Lauer, Robert Lesnick and Leslie E. Matson. Pp. xi + 277. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 17*s*. 6*d*.

THE use of the word 'fundamentals' in the title of this book is fully justified. A careful and detailed analysis of the physical principles underlying the operation of servo-mechanisms is made, with relation, in particular, to mechanisms for position control. The mathematical treatment is, in the main, on the transient basis—that is to say, the application of a 'step velocity' input—and deals in separate chapters with systems employing viscous output damping, error-rate damping, integral control and the various combinations of these features used

in practice. It is noteworthy that the mathematical analysis is by straightforward classical methods very fully detailed, no recourse being made to operational methods or other specialized techniques. This is a valuable feature, for the presentation is, in consequence, well suited to the student with no greater mathematical background than that of the regular undergraduate course in science or engineering.

While emphasis is placed rather on the characteristics and performance of systems of generalized type, attention is also given to the nature and behaviour of the various elements in the mechanism. Error-detecting devices are considered in a chapter devoted to 'follow-up links', and a further separate section deals with typical electrical networks employed in connexion with error-rate stabilization. Only brief attention is given, mainly in the final chapter, to the amplifier controlier.

Along with the detailed solutions of the differential equations for step velocity input, which constitute the main body of the theory, is given a brief development of the solutions for sinusoidal input. This is extended in a chapter dealing with the transfer function analysis of servo-mechanisms. The correspondence with feed-back amplifier theory is demonstrated, and the application of the stability criterion to servo systems is briefly considered.

A particularly valuable feature of the book is the number of worked numerical examples incorporated in the text.

A very effective effort has been made by means of detailed descriptions and the use of mechanical analogies towards providing a clear physical picture of the main phenomena of servo systems. Rather less successful has been the attempt made in Chapter 3 to provide, in the same volume, a condensed account of the basic mechanics and electricity required for the study of servo systems. The space occupied by this restatement of the elements of mechanical and electrical theory might have been more usefully employed in dealing a little more fully with the amplifier-controller element of the servo-mechanism and introducing the fundamental concepts of the effects of 'noise' in amplifying systems.

This book provides, however, a most satisfactory introduction to the principles of servo-mechanisms.

THE LAURENTIAN HORMONE CONFERENCE

Recent Progress in Hormone Research

Proceedings of the Laurentian Hormone Conference. Vol. 1. Edited by Gregory Pincus. Pp. v+399. (New York : Academic Press, Inc. ; London : H. K. Lewis and Co., Ltd., 1947.) 7.50 dollars.

THE Laurentian Hormone Conference had its origin at the 1943 meeting of the American Association for the Advancement of Science. The proceedings of the endocrinological section were so successful that the Montreal Physiological Society invited its participants to regather in Canada in 1944. A profitable reunion was held in the Laurentians, and the Laurentian Hormone Conference is now established as an annual event.

The present volume is a report of the 1945 meeting, and consists of four main sections, the first on neuro-humoral relationships, the second on the chemistry and physiology of adrenal hormones, the third on the role of hormones in metabolic processes, and the fourth on aspects of clinical endocrinology. Each section comprises from two to four general papers, followed by a record of the subsequent discussions.

It is difficult to single out, from what is a collection of well-chosen and well-presented papers, any particular contribution for detailed mention. Beach's paper on "The Hormones and Mating Behaviour in Vertebrates" is undoubtedly the best review that has yet appeared on the subject. The conclusions he draws from the available information are : (1) that some hormones affect sexual behaviour by virtue of their control of general metabolic processes, (2) that some types of sexual behaviour are independent of hormonal control, (3) that other patterns of sexual behaviour are specifically affected by hormonal stimulation, and (4) that where hormones affect sexual behaviour patterns, they do so by increasing or decreasing the sensitivity to external stimulation of cortical nervous circuits.

Another paper which is of particular importance, in so far as it presents a novel survey of newer knowledge, is Kochakian's review of the role of hydrolytic enzymes in some of the metabolic activities of steroid hormones. This paper shows that the metabolic effects of the steroids affecting protein anabolism work partly through the kidney, while those affecting protein catabolism function primarily through the liver.

A third most valuable review is Albright's on the effect of hormones on osteogenesis in man. This is a brilliant summary of the available knowledge on bone growth and of the effects of various types of endocrine stimulation on the process.

It is almost invidious to mention these three particular reviews. All the contributions to the volume are of the greatest importance, and it is to be hoped that future Laurentian conferences will be as well reported. Those who cannot attend the meetings will be even better pleased if the interval between conferences and the appearance of their Proceedings can be reduced. In the present instance, the date of publication is 1947, while the meeting took place in 1945.

S. ZUCKERMAN

PRACTICAL BRITISH FORESTRY

Practical British Forestry

By C. P. Ackers. Second edition. Pp. xviii + 394. (London : Oxford University Press, 1947.) 20*s*. net.

THE first edition of this book was reviewed in *Nature* of October 8, 1938 ; for the new edition, the chapters on nursery work and the future have been rewritten.

In the chapter on the future, the author discusses the changes brought about by the Second World War. He considers that the fully trained forester will be essential in the future, though in short supply, and that private forest owners will not be able to compete with Government for trained men. These statements are not quite in accordance with the existing position. There must be well over a couple of hundred men training at the present moment at the four universities, Oxford, Edinburgh, Aberdeen and Bangor, for the forestry degree. There are well over a hundred at Edinburgh alone. Out of this number it should be quite possible to provide good men for private forestry. The onus of taking

this step does not lie with the educational centres, but with the private owners themselves. As has been advocated for a number of years now, if a few adjacent private owners of forest land would join together, they could easily afford to pay for the services of a man who has taken full training in forestry and done well at his examinations. In any event, wherever a man goes, to whatever Government service, he will have to learn the ropes during his first year or more before he can become fully efficient in carrying out the work of the department in question. This holds equally good for the young fully trained man appointed to private forestry; but the bogy that they will be carrying a 'dud' for three to five years is entirely without reason: and to sit and wait, as some owners of private estates have been doing for the last forty years in some cases, until they can pick up a fully trained man with full experience—obtained, it may be well asked, from where?—is not, it may be suggested, the way in which Mr. Ackers' aspirations will be fulfilled. That such trained men are fully as necessary to the management of large areas of private forests as to the large areas under the Forestry Commission is so obvious that it does not need discussion.

In the chapter on the nursery the following topics are dealt with: temporary nurseries; choice of a nursery site; shelter; cleanliness; soils, of course, and then seed and its extraction; period of sowing; depths of sowing and covering, and sowing distances; the collection of seed, and the dangers to which both seed and young plants are subject from birds, mice, moles, damping off and frost; the size of the plants to be put out in the forest; transplanting in the nursery from the seed beds; use of manures and rotation of areas in the nursery; season of planting; transport troubles and the use of sets and cuttings; packing and unpacking, and heeling the plants on arrival at their new position, previous to planting them out.

As in the former edition, the present one contains a number of good illustrations. The author may be congratulated on his presentation of the subject.

E. P. Stebbing

EARTHQUAKES AND VOLCANOES

Séismes et Volcans

Par Prof. J.-P. Rothé. (Que sais-je?, No. 217.) Pp. 136. (Paris: Presses universitaires de France, 1946.)

THIS small book, with approximately the size and format of a British Penguin book, is believed to be the first written by Prof. J.-P. Rothé, of Strasbourg, the seismologist and son of the late Prof. E. Rothé, the distinguished French geophysicist. It is a worthy beginning. The book is accurate though semi-popular.

The five chapters concern the study of the visible effects of severe earthquakes, instrumental seismology and an earth model, earthquake geography, the supposed causes of earthquakes, and there is one chapter on volcanoes. The selection of material for the book has evidently been carried out with considerable care. Three earthquakes especially mentioned are the Provence earthquake of June 11, 1909, the Chilian earthquake of January 25, 1939, and the Roumanian earthquake of November 10, 1940. In a book of this sort it is a definite benefit to have large earthquakes mentioned which have occurred recently, even though there have been greater ones well described in such books as those by Dr. Charles Davison. The Chilian earthquake was undoubtedly one of the greatest earthquakes of the world and was so figured in *Nature* at the time. The macroseismic study of earthquakes still demands attention, for although it may be possible for an earthquake to start in a volume approaching a point, yet the mechanics of plane faulting figure largely both in the immediate cause and effect of earthquakes. Hidden faults have been mapped by instrumentally determined earthquake foci.

The chapter on seismic waves states clearly the elementary ideas underlying earthquake-recording instruments and the records obtained from these, and points out named waves on the records. The paths of these waves are shown on an earth model. There are no mathematics in the chapter, and seismic prospecting is confined to two pages. Seismologists and seismic prospectors will look forward to the promised book by the Rothés which is now being prepared.

The general outline of earthquake geography including deep-focus earthquakes as proved by Scrase is well described, and the regional earthquake geography of two well-explored regions, California by numerous American seismologists and the European Alps by J.-P. Rothé, is ably summarized. I myself feel that more modern attention to such subjects as are dealt with in "La Géologie Séismologique" by Montessus de Ballore would amply repay the time spent.

The 'causes' of earthquakes is a thorny subject, especially where it links up with isostatic theory. Epeirogenic and orogenic movements are considered and emphasis is placed on structure. The convection hypothesis, which incidentally assumes finite viscosity at moderate depths in the earth, is dealt with in conjunction with the gravity axis of Vening Meinesz near the Dutch East Indies. The theory of Wegener concerning moving continents is also mentioned.

Any theory of the origin of earthquakes must be capable of explaining the known facts of earthquake geography, such as the circum-Pacific belt and the South European–Asiatic belt, together with the limited distribution of deep-focus earthquakes and the gradual deepening of foci as we go from Spain via the Pamirs to Java. Seismology as an independent science is still young and has made great strides during the past forty years. That there are more problems to answer is a spur to those working on the subject. That the science is growing quickly is seen by the fact that the latest use of microseismic movement as a storm-centre locator at sea, and thus the use of the seismograph as a meteorological instrument, is not mentioned in Rothé's book.

Volcanoes are associated with earthquakes in the minds of people probably because both are catastrophic and unpredictable, and because both often occur in the same countries. Apart from both being associated with 'young' mountains, they have little else in common. This is made clear in a very concise terminal chapter in this admirable little book.

The books in this series "Que sais-je?", published by the Presses universitaires de France, together form a popular modern encyclopædia on most branches of human thought. Sixty-eight volumes on pure science are mentioned on the cover. The general idea is commended to publishers of British Penguin and other low-priced books. Ernest Tillotson

X-Ray the City!

The Density Diagram: Basis for Urban Planning. By Dr. Ernest Fooks. Pp. 108. (Melbourne: Ruskin Press, 1946.) 12*s*.

IN this essay on the general principles of town-planning, Dr. Fooks, emphasizing that population density should form the starting point for urban planning, reviews the methods already suggested for measuring the density of population in urban areas and then suggests a new method which would enable a comparable analysis of different cities to be made, free from the confusion of arbitrary administrative boundaries which constitute the major defect in density figures in relation to a whole urban or metropolitan area when considered as a basis for urban development or rehabilitation. To overcome this defect, Dr. Fooks proposes to introduce clearly defined notions for expressing the environmental factor of urban living conditions and for measuring population distribution, and to illustrate the distribution of the population within urban areas by means of the diagram of population density in its various forms, based on the distance grid. He would then replace the vague overall density figures by distance-density figures and distance-density factors; and superimposing on a city plan a circular distance grid, and calculating the densities for individual segments of each concentric ring, he obtains a rational area density diagram which can be used effectively, if not universally, to implement the sociological approach to planning of which Lewis Mumford, F. J. Osborn, T. Sharp and Ebenezer Howard have been such eloquent exponents.

The various functions and facilities of a town can also be analysed on this grid basis, and quite apart from the international adoption of the method for which Dr. Fooks pleads, its interest and bearing on the various proposals for new and satellite towns in Great Britain need scarcely be stressed further.

The book is well produced and illustrated, and an excellent bibliography also enhances its general appeal, apart from its value as a scientific tool.

R. BRIGHTMAN

Alternating Current Electrical Engineering

By Philip Kemp. Seventh edition. Pp. ix+660. (London: Macmillan and Co., Ltd., 1947.) 25*s*. net.

THIS is essentially a students' text-book. It has already served, in six editions, many generations of students and should in the new edition continue to enjoy a well-merited popularity. A good deal of new material has been introduced and considerable sections of the text have been re-written.

In its scope and treatment this book is particularly suitable for use in connexion with National and Higher National Certificate courses, and it should also serve as an introductory text-book for engineering degree courses.

The difficult task of selecting the subject-matter has, in general, been well done; the exclusion, for example, of electronic phenomena and apparatus except in relation to mercury arc rectifiers. It is, however, questionable whether, having regard to present practice, the twenty-five pages devoted to rotary converters are justified.

In a book covering so wide a range of material the treatment of many topics is necessarily somewhat superficial, but in general the essentials are emphasized and a satisfactory picture presented. There are, however, occasional cases of lack of clarity of expression, as, for example, where it is stated on page 281 that "The advantages of hydrogen as a cooling medium are reduced windage and ventilation losses, due to the density of the gas". The treatment of fundamental matters is in the main thorough and satisfactory, but it is regrettable that such an important question as the sign convention which determines the 120° phase displacement of three-phase currents or voltages receives rather scant attention.

J. G.

Die hormonalen Aspekte des Fortpflanzungsprozesses

Von Dr. Jules Samuels. Pp. v+152. (Amsterdam: Holdert und Co., N.V., 1946.) n.p.

Die Hormonversorgung des Fœtus

Von Dr. Jules Samuels. Pp. vii+320. (Leiden: E. J. Brill, 1947.) n.p.

DR. SAMUELS is a gynæcologist and clinical endocrinologist of Amsterdam, and believes that the development of the fertilized ovum is under the direct control of the gonadotrophic hormones of the pituitary and chorion. He also believes that the thyrotrophic factor of the pituitary is identical with the luteinizing factor, and that both the sperm and the ovum contain a store of gonadotrophic substances. These views are a series of speculative and somewhat obscure conclusions derived from a general review of the literature. They are at variance with the more usually accepted conclusion, derived from experimental study, that the gonadotrophic substances exert an influence only on the pre-fertilization phases of development of the gametes. The burden of proof of Dr. Samuels' theses rests upon his shoulders, and until he can provide experimental support for his views they are scarcely likely to command more than occasional interest.

The Gemmologists' Compendium

By Robert Webster. Second edition. Pp. 241+20 plates. (London: N.A.G., Ltd., 1947.) 15*s*.

IT is ten years since this Compendium first appeared. Much additional matter has been incorporated in the new edition. The extensive glossary which constitutes Part 1 includes not only definitions of precious and semi-precious stones, and the trade names by which they are sometimes known, but also explanations of the various technical names used in connexion with the scientific study of gem stones. It has been enlarged, and now occupies one half of the book. Part 2 also has been extended, and deals very thoroughly with the optical, physical and chemical properties and characteristics of precious stones, and the technical methods by which these properties can be determined. Numerous tables of optical and physical constants are included, and there is also a section on artificial gem stones and the methods by which they can be recognized. Among the illustrations are twenty excellent plates, nine of which are coloured. Irrelevant matter of the type often found in books on gem stones, relating to their history and æsthetic value, has been completely omitted; but the book contains a vast amount of accurate and useful technical information arranged in a compact and convenient form. It is primarily intended as a *vade mecum* for jewellers and traders in precious stones, to whom it should prove invaluable; but it also forms a very useful ready-reference work for all in any way interested in gem stones, whether in a professional or amateur capacity.

CROSS-LINKING IN POLYMERIC SYSTEMS

By Dr. G. F. BLOOMFIELD

THE mechanical properties of a natural or synthetic polymer are profoundly affected when the van der Waals' intermolecular forces are supplemented by stable chemical linkages (cross-linkages) between the polymer molecules. In synthetic polymers, cross-linking may generally be brought about either as an essential part of the polymerization reaction, or by chemical modification of the polymer subsequent to polymerization; but cross-linking in natural rubber can only be accomplished by the latter method. Although cross-linkages in synthetic rubbers could be introduced during polymerization if desired, they are, in fact, excluded so far as possible; hence, as with natural rubber, it is necessary to carry out the cross-linking reactions on the polymer itself. In a recent series of lectures at the Royal Institution, London, various types of cross-linking mechanisms and their effect on the properties of polymers were discussed. Dr. H. P. Staudinger dealt with the cross-linking of vinyl polymers, the present writer discussed the structural modification of high polymers by vulcanization, with particular reference to rubber, and Dr. L. R. G. Treloar described the relation of mechanical properties to the degree of cross-linking in rubbers. Phenol-formaldehyde resins, in which the role of cross-linking reactions is rather less clear, were surveyed by Mr. E. G. K. Pritchett. My thanks are due to the board of the British Rubber Producers' Research Association for permission to contribute to this series of lectures and to prepare the following summary of them.

Permanent cross-linkages prevent irreversible flow and so contribute essentially to the reversible character of a deformation. Resistance to plastic flow, to thermal deformation and to solvents is thereby increased. A low degree of cross-linking, that is, less than one cross-linkage per polymer molecule, is insufficient to impart any real resistance to deformation, since the interlinked molecules still behave essentially as a linear, although highly branched, molecule; but as soon as two or more cross-links per molecule are introduced, there results a network in which flow is impeded. A high degree of cross-linking, on the other hand, leads to a highly rigid structure.

In order that rubber-like elasticity may be realized, some compromise is necessary between flow and rigidity, excessive cross-linking leading to a complete loss of rubbery characteristics.

Vinyl polymerization provides a useful means of studying the effect of cross-linking on the physical properties of polymers, particularly the flow properties, if the second-order transition temperature, Tm, can be taken to indicate the onset of viscous flow. A close relation between Tm and the average number of vinyl monomer molecules between cross-link junctions can be established. Cross-linking may be accomplished either by co-polymerizing bi- and tetra-functional monomers (for example, styrene with divinyl benzene, methyl methacrylate with allyl methacrylate), or by chemical reaction of a linear polymer containing reactive substituent groups with a substance of low molecular weight (for example, a copolymer of methyl acrylate and maleic anhydride is treated with ethylene glycol). In the first category the properties of the product may range from solubility and fusibility to complete insolubility and infusibility, depending on the relative amount and on the nature of the cross-linking agent in the co-polymer. Although in its initial stages the process of cross-linking with tetra-functional monomers can be interpreted by the kinetics of co-polymerization as applied to bifunctional monomers, where the relative amounts of the monomers and the relative reactivity of their double bonds are the determining factors, a full kinetic interpretation becomes extremely difficult, once inter- and intra-molecular reactions between polymer chains occur as part of the growth process in addition to the four growth reactions which are possible between polymer radicals and monomers. Fundamental differences in the polymerization mechanism arise when the degree of cross-linking is sufficient to give a gel due to a three-dimensionally interlinked network structure, for although the polymerization-rates are not significantly changed when the concentration of the cross-linking reagent is low, there is a marked increase in rate, coinciding with the appearance of the gel, when more of the cross-linking component is used.

Considering that termination is a bi-molecular reaction with respect to polymer radicals, the high viscosity of the medium—which is infinite once gel formation has occurred—will restrict diffusion of, and reduce collision between, polymer radicals, thus reducing the termination-rate; while propagation, involving diffusion of, and collision with, monomer, is little affected.

In order to exercise some measure of control over cross-linking by copolymerization, it is desirable to select types of double bond of widely different reactivities within the cross-linking molecule, the ideal being to produce a linear molecule by polymerizing the vinyl bonds, and then to promote a cross-linking reaction involving the less reactive bonds by a rather more drastic treatment. In practice, polymerization is first conducted to a point short of gelation, and the resulting syrup is used for casting or impregnation. An outstanding advantage of the new technique is that it requires no high-pressure equipment, and is accordingly very suitable for the fabrication of structures of considerable size.

A particularly undesirable form of cross-linking in vinyl polymerization is that responsible for 'popcorn' formation, in which small particles resembling popcorn grow rapidly with considerable volume expansion. 'Popcorn' formation is determined mainly by temperature and the proportion of cross-linking agent, consequently control involves both of these two factors. 'Popcorn' can itself initiate fresh 'popcorn' growth in virtue of its hydroperoxide content, or as a result of electronically stabilized radicals becoming reactive.

In cross-linking by chemical modification subsequent to polymerization, it is necessary that the polymer should contain functional groups (for example, ethylenic linkages) or reactive substituents (for example, halogen, hydroxyl, carboxyl).

An important aspect of cross-linking by chemical reaction is that comprising the whole field of rubber vulcanization; in fact, any reagent which is capable of providing intermolecular linkages between two or more polymer molecules is capable of vulcanizing rubber. The properties of the resulting vulcanizate, however, depend not only on the nature and number of the cross-linkages, but also on the possibility of side reactions and on the treatment necessary to promote reaction, and consequently they vary widely.

Rubber vulcanizing agents fall into two classes: those giving rise to radical reactions leading to carbon-carbon cross-linkages, and those which affect bridging through the agency of a bifunctional atom or molecule which itself forms the cross-linkage. The simplest example of carbon-carbon linking is provided by photogelling; cross-linking reactions of benzoyl peroxide, diazoaminobenzene and other reagents which decompose thermally to give free radicals are believed to follow a similar course. Bifunctional reagents include dinitroso compounds, azodicarboxylates, hydrogen sulphide, dithiols, sulphur chloride, and, most important in technical rubber practice, sulphur. The essential cross-linking reaction of sulphur consists in the establishment of a polysulphide bridge between two of the originally unsaturated molecules, with loss of one of the original double bonds and a displacement of the other. A necessary prerequisite of a cross-linking agent is that it shall react intermolecularly. The 1 : 5 diene system in rubber is, however, particularly prone to form intramolecular cyclic linkages when the reagent contains only one or two atoms between its reactive ends, and sulphur is no exception. The formation of tetrahydrothiopyrans has been demonstrated in the reaction of sulphur with small polyisoprenic molecules, and the low efficiency of sulphur as a cross-linking agent for rubber is undoubtedly to be attributed, at least in part, to its participation in cyclic linkages of the tetrahydrothiopyran type. A contributory cause of the low efficiency of sulphur is its participation in polysulphide rather than monosulphide cross-linkages. Rubber vulcanization is consequently very susceptible to small amounts of auxiliary substances capable of promoting intermolecular rather than intramolecular linkage, or capable of promoting monosulphide rather than polysulphide cross-linkages. Certain accelerated vulcanizates accordingly exhibit a much higher efficiency of cross-linking, although they still fall short of the theoretical maximum of one cross-linkage for each sulphur atom incorporated.

From the theoretical point of view, a vulcanized rubber is visualized as a three-dimensional network of molecules, the mechanical properties of which may be calculated by the methods of statistical thermodynamics. The physical basis of this approach is the assumption that the individual chains (or portions of molecules between successive junction points) are in a state of random thermal fluctuation of form, by virtue of the relative freedom of rotation about single bonds in the chain. This kinetic basis provides a reasonably satisfactory quantitative background for such physical properties as the form of the stress-strain relations in any type of strain, the effect of progressive vulcanization on tensile strength, the optical double refraction due to strain, and the principal phenomena of swelling in diverse liquids. By the use of certain simplifying assumptions it is possible to derive the following force-extension curve for a vulcanized rubber:

$$F = (\rho RT/M_c)\,(\alpha - 1/\alpha^2), \qquad (1)$$

where F is the tensile force, referred to the original cross-section, α is the ratio of the stretched to the unstretched length, ρ the density and M_c the 'molecular weight' of the chains between successive points of cross-linkage. Two interesting features of this equation are worth noting: first, the form of the stress-strain curve is determined by $(\alpha - 1/\alpha^2)$, and should therefore be the same for all rubbers, whatever their chemical constitution; and secondly, the modulus $(\rho RT/M_c)$ should be inversely proportional to M_c, the chain-weight between points of vulcanization, or alternatively, directly proportional to the number of cross-links.

Generally speaking, these theoretical predictions have been borne out experimentally. For a series of rubber-sulphur vulcanizates Gee observed a direct proportionality between modulus and percentage of combined sulphur, while Flory, in a comprehensive investigation of a range of butyl rubbers, obtained close agreement with the slightly modified formula

$$F = \rho \frac{RT}{M_c}\left(1 - \frac{2M_c}{M}\right)(\alpha - 1/\alpha^2) \qquad (2)$$

(M is molecular weight before vulcanization, M_c is molecular weight between junction points), in which the effect of terminal chains connected to the network at one point only is allowed for.

The swelling of rubbers by liquids is a phenomenon closely related to the mixing of two liquids. For a good swelling agent it is found experimentally that the absorption of the solvent is accompanied by very little change of energy. It is, however, accompanied by a very large change of entropy. Equilibrium swelling is achieved when the entropy increase due to the absorption of an additional small quantity of liquid is balanced by the entropy decrease due to the expansion of the elastic molecular network. Both the entropy of mixing and the network entropy can be calculated, and in this way it is possible to predict quite accurately how the maximum swelling will depend on the degree of cross-linking. Since the modulus also is determined by the degree of cross-linking, it follows that there should be a close relation between the modulus and the maximum swelling for a series of rubbers of different degrees of cross-linking. The quantitative relation worked out by Flory indicates that the modulus should vary inversely as the five-thirds power of the maximum swelling ratio—a relation which was found to be very closely borne out by Flory's data for butyl rubbers.

A phenomenon which is at first sight rather surprising, and for which, until recently, no explanation had been given, is the rapid fall in the breaking strength of natural rubber vulcanizates which occurs when the degree of cross-linking is increased beyond the optimum value. In a recent publication by Gee, evidence is brought forward which indicates that the effect may be explained in the following way. With increasing cross-linking the modulus continuously increases, and at the same time the elongation at break tends to fall progressively. But with reduced extensibility there is reduced molecular orientation and therefore very probably a reduction in the degree of crystallization. It is this reduced crystallization which gives rise to the reduction in tensile strength, since the crystallites have the effect of introducing strong binding forces between the molecular chains.

In the field of thermosetting resins, the role of cross-linking reactions is by no means so well established as in vinyl polymers and in rubber. Although the conception of cross-linking by methylene groups at the *p*-positions of the benzene rings is widely accepted, there are difficulties in the general application of this principle, since it is not at all certain that hydroxyl groups may not also be involved in the thermosetting reaction; and it is noteworthy in this respect that *p*-cresol resins show some thermosetting properties. Models indicate that methylene-linked structures are extremely rigid, since rotation of the

benzene rings is very restricted sterically ; thermo-setting linkages may possibly involve only a few of the benzene rings, so giving a plausible explanation of the low tensile strength of phenolic resins. An entirely new conception proposed by E. G. K. Pritchett envisages a mechanically interlinked rather than a chemically cross-linked structure, the extreme rigidity rendering the substance insoluble and infusible.

SALMON AND ANIMAL MIGRATION

By Dr. A. G. HUNTSMAN

Fisheries Research Board of Canada and University of Toronto

MORE than two thousand years ago, Aristotle wrote that all the actions of animals are for breeding, for feeding and to avoid extremes[1]. Clearly such motivations of migration satisfy those who ask why animals migrate ; but have they been verified and are they verifiable ? Are they still accepted as explanations of migration, the only problem being to discover how the animal can accomplish wonderful feats ? Has such an attitude been successful in elucidating migration ? The statements that for birds "this question has been extolled as a mystery of mysteries"[2] and that for the salmon migration is accomplished by "an instinct which man cannot comprehend"[3] are not reassuring.

If the matter is not yet clear, it may be because the proper approach has not been used. Perhaps migration should be considered merely as wandering, as was the original meaning. Facts against the prevalent ideas have long been known[4] ; but no attempt seems to have been made to develop theories to include them, except as divorced from 'true migration', which has the idea of purpose either of the animal or of 'Nature'. It is not clear how we can verify the animal's purpose, and, as to Nature's purpose, it may be a mistake to assume that the animal's behaviour should be useful for survival, rather than merely not incompatible with survival of some of the race somewhere. If migration is merely wandering, that is, changing the place of abode, the problem is when and whither will an animal wander in view of its nature and of the conditions to which it is exposed. There has been a growing tendency to treat the matter thus objectively, which may permit accurate prediction.

For more than a decade, the Fisheries Research Board of Canada has been intensively studying the salmon (*Salmo salar*) as a somewhat representative fish. This study has provided the main facts with which we are attempting to develop a true science of fish migration.

No simple method of salmon behaviour will permit accurate prediction, since they behave most variously, as the following examples show. They may or may not spawn as parr before moving from the locality where they were spawned. On metamorphosing into smolts in the spring, they fail to spawn in that year and may or may not spawn in subsequent years up to the fifth. Usually, parr remain in streams, smolts and kelts (adults after spawning) descend, and near-spawning adults ascend ; but salmon may or may not descend to or ascend from the sea as parr[5], as smolts, as near-spawning adults and as kelts[6]. Clearly, the idea that their migrations are between breeding grounds in rivers and feeding grounds in the sea is inadequate. Some differences in behaviour have been ascribed to differences in original nature (sub-species or races) ; but for none of these has the original nature of the individuals been shown to be different, while correlations with environmental differences are evident and experiments fail to show that offspring of those behaving differently will behave differently under the same conditions, for example, for descent to the sea, that is, "migratory and non-migratory races"[7] or for time of return to streams, that is, "early and late running races"[8].

One theory that fits the facts, but that can be only part of the complex whole, is quite simple. It is that in the rapid water of a stream the fish is carried down (as it must be more or less) in its descending, and swims actively up (as it must) in its ascending migration, these being the only directions in which stream fishes can migrate. The well-known upstream orientation of fishes, or rheotaxis, which may or may not be elicited by the flowing water, depending upon the conditions, and the more or less active swimming of the fish are all that the theory requires. Underyearling salmon have been found to vary sufficiently to separate into two groups when placed in a rather strong shallow current—those that ascend and those that descend—but they all head upstream. Similarly, when with a strong freshet in the rivers the salmon in the sea left the east coast of Sutherland near Brora for the rivers, 'droppers', that is, salmon that had ascended the rivers and remained there for some time, but had dropped down again, appeared in coastal nets[9].

When entering the smolt stage for which descent is typical, salmon behave most variously. With higher, that is, swifter water, more descend[10,8]. Some descend quickly, some very slowly, and some fail to descend ; yet they would all leave the stream in a few hours if they merely kept up from the bottom and headed downstream. Smolts marked as they left Forest Glen Brook for the large North-East Margaree River, Nova Scotia, in the spring of 1938, arrived at a trap fifteen miles down that river in from 1 to 28 days or more. It is judged that they all could, if headed right, have descended in 12 hours. In swift water they descend tail first swimming vigorously upstream, and they sometimes ascend rapids, as may be seen when they near a trap placed in swift water. That in slow water descending fish all head downstream into a trap may mean nothing more than that all the others, if swimming faster than the water flows, are certain to be moving up-stream, since the narrowness of the stream prevents movement any distance in directions other than up and down. In a lake, roaming near the surface would be apt to take them near enough to the outlet for the current to act.

In September and October of 1945, smolts were still to be found above beaver dams in Holmes Brook near Moncton, New Brunswick, in spite of freshets that were thought to have brought them down. This finds explanations in observations by Mr. C. W. Andrews in trapping smolts on the neighbouring Pollett River. With quite low water in 1944, smolts known to be in the pool above the trap failed to descend during the forty-three subsequent days of operation of the trap and no rise in water. In late evening he saw them to have descended to the brink of a shallow rapid, and they moved back up to the pool by morning. Clearly, when near the surface and down to this rapid in the

evening, strong rheotactic reaction due to their nearness to the bottom[11] caused them to swim upstream more rapidly than the current carried them down. With deeper water, they would face less stimulus when at the surface and the current would be stronger. He showed experimentally in 1946 that increase in water-depth at the rapid from four to twelve inches or more resulted in descent of smolts into the trap. In work in progress, underyearling salmon in round rearing pools are seen to migrate downstream, swimming with the current, in a zone of weak current up from the bottom, when in poor condition and at unfavourably high temperature. On these and other facts is based the conclusion that salmon descend when they both wander about and fail to react strongly enough in current to remain upstream. Evidence fails of salmon at any stage heading downstream in response to strong current.

Upstream migration is more easily understood, since fishes react to current by heading upstream. Salmon may ascend from the sea a year before spawning. Even when congregated at the river mouth, they frequently fail to ascend when ascent is easy with low, slowly flowing water, but ascend quickly in spite of the greater energy required with the increasing flow of a freshet (even artificial), unless the flow is quite strong[12]. Also, they ascend at times at least a short distance when the river water is so warm that they are killed by heat stroke[13]. On these and other facts is based the conclusion that salmon ascend when they both wander about and are sufficiently stimulated to swim upstream in rapids. The stimulus may come from increase in stream flow, from wandering of the salmon into more rapid waters or in other ways.

Even a stream in heavy flood has relatively quiet water at intervals where salmon will remain if resting on the bottom. It will depend upon how they move and how the water moves as to whether or not they migrate when active. Rheotaxis is the reaction of stream fishes that permits them to continue living in streams when they move about, their swimming upstream counterbalancing the current which would otherwise carry them out. This orientation is effected through relation with the bottom, even to frequent contact[11], which relation diminishes and disappears with increase in distance of the fish from the bottom.

A one-way current and a variable counter-current reaction by the fish form a proper basis for Meek's[14] denatant-contranatant theory of migration. Salmon are clearly to some extent both denatant (going with the current) and contranatant (going against the current) at all stages, so that the theory is applicable to them in one-way freshwater streams of sufficient strength and shallowness, as observation readily shows. In pools with deep, very slowly moving water, evidence for it fails and other factors must operate. Meek's theory has been used to explain migration of sea fishes, but proper evidence seems to be lacking, even for its action in estuaries. The facts given us as to the movement of salmon in estuaries, even shallow ones, are that they move inwards with flooding tide, that is, with, not against, the current. We have failed to get evidence of contranatant migration in the sea of either herring or salmon except in restricted tidal rapids with the fish not far from the bottom.

In general, movements of the salmon in the sea seem to be in all horizontal directions and more or less to and fro, as shown by the facts of their capture and of recapture of tagged fish. Their movements are clearly determined by the conditions they meet. They become inactive with the near zero (° C.) temperature of winter. Feeding actively as the water warms in the spring, they apparently do not roam and are not caught until they are ceasing to feed, which happens as early as May for large fish in eastern Canadian waters, but not until August for post-smolts, which corresponds with their relative fatness. They tend to hold position in rapids, which results in their collecting in channels and at river mouths. With steep salinity gradients, they tend to keep in water of low salinity, as the facts of their capture and of recapture of tagged fish show, which results in their reaching rivers. Also they tend to keep in water like that of the home stream[15], which is apt to take them sooner or later to the home stream, if far from it.

With such behaviour, they collect in the river outflow as the season progresses, but do not necessarily ascend. Some stimulus seems to be required for them to do more than swim sufficiently to hold position at the river mouth. A freshet may start their ascent, which is directed by rheotaxis. Underyearling salmon in a trough ascend quickly when stimulated by a local rapid increase in flow from lowering of the surface level downstream, although ascent then requires more effort. Adult salmon, when stimulated by the increased flow of a freshet, will for the most part not ascend when the current is strongest at the height of the freshet, but only as the current weakens. When sharp, stimulating, artificial freshets were made in the Moser River, Nova Scotia, in the dry season of 1942, more than twice as many salmon entered as were to be expected from counts of smolts and adults for the preceding three years[11], with the water generally so low that the fish could be readily caught in the evening on the rapids by poachers who made rough traps or mazes of stones for the purpose. With such freshets in the somewhat wet season of 1943 and with the native grilse having been marked the previous year as smolts, from one quarter to more than one half of the entering grilse were unmarked and presumably foreign fish[16], the proportion rising with advance in the season and particularly with heavy floods that doubtless brought in fish that were farther out to sea. Even through the spawning period, with continued absence of freshets from summer to the December freeze-up in 1946, salmon did not appear in traps operated on Holmes Brook, North River and Bennett Brook above the main Petitcodiac River, as they had done in previous years in going to spawning grounds, even though some were in the main river from mid-summer[17]. If salmon must be stimulated to go upstream to spawn, should they be used as the chief example among fishes for true migration, defined[18] as "a racial custom, enregistered in the animal's constitution"?

With pressure of a dense population, planted salmon spread more widely, as planting experiments have shown. The facts indicate that the brook trout (*Salvelinus fontinalis*) shows this factor by failing to migrate down to the sea when heavy fishing lessens population pressure. The room required to stop migration changes with increase in size of fish, so that large fish are generally found in lower, larger waters. Planting of tagged kelts above Shubenacadie Lake has just shown extent of descent to large lakes or the sea to be correlated with the size of the fish.

I am deeply grateful to many colleagues who, with other ideas, have kindly responded to appeals for

criticism, greatly aiding this presentation of the matter.

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SUBMICROSCOPIC STRUCTURE OF THE BACTERIAL CELL, AS SHOWN BY THE ELECTRON MICROSCOPE*

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THE wall of the bacterial cell is solid. The cell-wall may maintain its approximate shape after cytolysis; on breaking it may present a jagged line of fracture[1]. Within the cell-wall, and normally doubtless closely applied to it, is the cytoplasmic membrane enveloping a fluid or potentially fluid protoplasm. In electron micrographs the protoplasm often is appreciably separated from the cell-wall[2]. This is doubtless a shrinkage artefact due to desiccation in the electron microscope, which operates in a high vacuum. The protoplast and in particular the cytoplasmic membrane are stained and visible, the cell-wall unstained and not seen, in routine bacteriological preparations. Flagella, if present, arise from the protoplast and pass through the cell-wall, at least in vibrios. They are of uniform diameter somewhat characteristic of the bacterial species. They are not artefacts or mucous threads[3]. Capsules, as in the case of the pneumococcus, are extracellular gels surrounding the cell-wall[4].

Combination of bacterial antigens with antibodies may be directly observed with the electron microscope. Specific antibodies combine with somatic and flagellar antigens of non-capsulated bacteria to form surface deposits, respectively, on the cell-wall and flagella[5]. Non-specific components of serum (complement) may be adsorbed secondarily on the antigen-antibody complex[3]. Antiserum permeates the capsular gel of the pneumococcus; antibody combines with homologous capsular antigen and non-specific serum components are adsorbed; the swollen gel resulting is opaque to electrons[6].

Study of the internal structure of the bacterial protoplast has been retarded by the 'opacity' to electrons (diffuse scattering of electrons) of the protoplast, in particular of Gram-positive species, and by insufficient contrast of structures within the protoplast. In the special case of the sporulation and spore germination of an aerobic bacillus (*Bacillus mycoides*), Knaysi, Baker and Hillier[7] have revealed much additional detail by the use of a research model electron microscope operating at higher than ordinary voltage (150 kv.).

Knaysi and Baker[8] have also discovered an elegant method of making internal structure more apparent. *Bacillus mycoides* is grown in a nitrogen-free glucose-containing medium, buffered with sodium acetate. Under these conditions the electron-scattering ribonucleic acid of the cytoplasmic membrane and protoplast is reduced to a minimum, and two types of internal structures are revealed. The first are opaque bodies 0·22 by 0·29 μ to 0·43 by 0·50 μ in diameter; one to six of these are found in each cell; these bodies are present in all stages of development; they divide; they are included in the forespore when sporulation occurs; they take nuclear stains. They are interpreted as nuclei.

The second type of bodies are thin, each with circular or elliptical outline; they are 0·08 to 0·17 μ in diameter; a few to about forty are present per cell. "They are part of the cytoplasmic membrane and, except when they appear homogeneous, they cannot be structurally differentiated from the rest of that membrane. Both seem to consist chiefly of a net-work of beaded threads and granules, probably representing complex molecules." Electron micrographs of *Bacteroides funduliformis* by W. E. Smith, Mudd and Hillier also show a finely reticulated structure of the bacterial protoplasm[9].

The structure thus far made manifest in the bacterial cell, even with the aid of the electron microscope, is much simpler than the remarkable synthetic capacities of bacteria would seem to require. Cells of many kinds of bacteria, furnished only with water, salts, glucose and simple sources of carbon and nitrogen, can synthesize proteins, complex carbohydrates, lipids, ribose and desoxyribose nucleic acids, growth accessories and enzymes, all organised into characteristic and reproducible protoplasmic systems. The cell can reproduce itself and divide within half an hour at body temperature. These feats of chemical synthesis and organisation, which cannot be duplicated by the finest chemical laboratories in existence, are accomplished within a cell a few microns in length and less than a micron in diameter. The plain facts would seem fantastic if they were not so familiar.

W. Seifriz, K. H. Meyer and others[10] have pointed out that the elastic and thixotropic properties of protoplasm imply a three-dimensional lattice of elastic and solvated protein molecules or micelles. The width and thickness of extended molecules of ordinary proteins (about 10 A. by 4·5 A.) are at, or just beyond, the present limit of resolution of the electron microscope, when full resolution is taken advantage of by use of the techniques of shadow-casting[11], or of surface replica[12]. Globular protein molecules[13] and fibres composed of a small number of aggregated, extended protein molecules are detectable under favourable conditions with the electron microscope. The electron micrographs of bacteria cited above and those of Porter, Claude and Fullam[14] of the hyaloplasm of fibroblasts are compatible with the reticular protein framework which has been postulated as necessary to explain the physical properties of protoplasm.

It may be useful to proceed in imagination beyond the present visual evidence of fine structure. The interstices of the reticulum may be supposed to be filled with an aqueous phase. The simultaneous occurrence of complex reactions, involving energy utilization, synthesis, and organisation of the

* From a Symposium on Electron Microscopy at the Nobel Institute of Physics, Stockholm, Sweden, July 16, 1947, in connexion with the Sixth International Congress for Experimental Cytology.

materials elaborated, implies means of keeping the reactions in proper temporal and spatial relation to each other, and implies organisation equivalent to an efficient system of transport and logistics. Substrates and enzymes must be brought together, the structural units of proteins must be synthesized and brought to the 'templates' at the surfaces of which further syntheses may be supposed to be determined; completed molecules must be added in their appropriate places to cell-wall, cytoplasmic membrane, nucleus, or even capsule or flagella, all in orderly, rapid and reproducible sequence.

Necessary segregation of reacting systems may be effected in part by the internal organisation of the submicroscopic particles present in protoplasm[10]. Some of the requirements of segregation and of transport may be supposed to be met by films of lipid or of lipoprotein across the interstices of the fine reticulum of the protoplasm. Lipid-aqueous phase interfaces tend to adsorb polar–non-polar molecules and particles and to transport them along the interface from regions of low to regions of higher interfacial tension[15]. The effects of oriented molecules in such interfaces on the orientation and distribution of molecules in the adjacent phases may be supposed to be additional factors in organisation[16].

Such considerations furnish only an imaginative sketch, in vague and general outline, of some of the features of the fine structure of bacterial protoplasm. Are there reasonable grounds for hope that electron microscopy may throw light on the actual fine structure of protoplasm? There are such grounds. The micellar and macromolecular fine structure of protoplasm is within the powers of *resolution* of even present-day electron microscopes. Analysis of the ultra-structure of nerve axoplasm[17] and of various fibrous structures[18] has indeed made significant progress. The problem of preparing specimens sufficiently thin so that fine structure is not overlaid and obscured, and with sufficient contrast so that fine structure is detectable, without essential alteration of the natural structure, has thus far only been partially achieved in a few favourable instances. Techniques of increasing contrast by selective combination with chemicals containing atoms of high atomic number[18,19] have been explored to the point of showing them to be feasible; but their exploitation has only begun. It is challenging at least to realize that study of submicroscopic fine structure with the electron microscope is limited by technical difficulties rather than by the inherent nature of image formation, as is the case with the light microscope.

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OBITUARIES

Dr. Henri Deslandres, For.Mem.R.S.

By the death on January 15 of Henri Deslandres, born in Paris on July 24, 1853, the Paris Academy of Sciences has lost its senior member, and astronomy and spectroscopy have lost one whose active researches go back more than sixty years. Destined for an army career, he resigned in 1881 when a captain in the Engineers and devoted himself to spectroscopy and astronomy. His earliest papers on band spectra date from 1885, and he continued his work until last year, publishing his last paper in the *Comptes rendus* within a week of his ninety-fourth birthday. Even at that age he suggested taking up fresh work as soon as sufficiently accurate material was available. Laws connecting the wave numbers of separate lines in the same band and of the heads of different bands are associated with his name.

In 1889 Deslandres was appointed an assistant at the Paris Observatory and placed in charge of the spectroscopic investigations. He at once began work on radial velocities of stars, on planetary rotations, on cometary spectra, and on solar physics. In his work on the photography of prominences and features on the sun's disk in monochromatic light, he developed the spectroheliograph independently of Hale, to whom, however, priority of invention was awarded; but he also designed the *spectro-enregistreur des vitesses*, which showed the sight-line motions of the gases giving the features in the monochromatic pictures. Instead of a very narrow second slit and continuous motion, he used in this instrument a wider second slit and obtained a series of stationary photographs of successive narrow sections of the sun's disk. How good his technique was, and what beautiful results he could obtain with both types of instruments, were amply shown after he became director of the Meudon Observatory on the death of Janssen in 1907. His work gave an insight into the circulation taking place in the solar atmosphere in disturbed regions, and laid the foundation for the excellent studies now continued by his colleague and successor, Dr. L. d'Azambuja. In particular, he examined the differences between the layers of the solar atmosphere photographed in different narrow sections of the lines $H\alpha$ and K. His work on sunspots and connected solar phenomena led to a study of the connexion with terrestrial magnetic storms, and of the nature of the charged particles emitted by the sun.

Deslandres was appointed director of the Paris Observatory in 1927 and retired in 1929. He was elected an associate of the Royal Astronomical Society in 1904, received its Gold Medal in 1913 and became a foreign member of the Royal Society in 1921. He received the Bruce Medal of the Astronomical Society of the Pacific and was a foreign member of many national academies. He remained mentally alert to the end of his long life, and died of pneumonia after several months of growing physical weakness.

We regret to announce the following deaths:

Prof. Selig Hecht, professor of biophysics in Columbia University, on September 18, aged fifty-five.

Sir Arthur Huddleston, C.M.G., O.B.E., director of the Royal Technical College, Glasgow, since 1933, and previously a member of the Sudan Political Service, on February 11, aged sixty-seven.

NEWS and VIEWS

Importation of Books into Britain

LORD BALFOUR OF INCHRYE, speaking in the House of Lords on February 19, directed attention to the effects of the present restrictions on the import of books into Britain. He said that we cannot afford to fall behind in the application of modern scientific developments, and due to the difficulty in publishing books there is danger that Britain will be cut off from the exchange of ideas and knowledge. He suggested the imposition of a maximum time-limit for dealing with applications for import licences, that the permissible quantities of book imports be increased, and that there should be blanket licences of specified amounts for universities, libraries and approved scientific bodies. Lord Chorley, Lord in Waiting, in reply, said that the President of the Board of Trade is discussing with representatives of the learned institutions their difficulties in obtaining books, particularly from the United States. As a result of those discussions, an increase in the quota may be granted, though he would not hold out a promise that it would be up to the 200 per cent of the pre-war amount which had been suggested.

Conscription and Industry

AN article by D. R. O. Thomas (*J. Inst. Personnel Management*, **29**, No. 293; September–October 1947) directs attention to the possible effect on industrial efficiency of the withdrawal of large numbers of young men for national service requirements. Under the Act, which becomes operative on January 1, 1949, men between the ages of eighteen and twenty-six years are to be called up for national service for a period of twelve months, the actual call-up age being eighteen, and thereafter each man will serve 5½ years with the reserve, during which he is required to do sixty days training. This, and the new developments under the 1944 Education Act in respect of the raising of the school age to sixteen years and the establishment of county colleges, will mean that industrial organisations will be faced with the prospect of starting youths in employment at sixteen years and afterwards releasing them for one day in five up to eighteen years, when they will disappear altogether for twelve months. On return to employment, the young man will be required to do two weeks Service training per year for 5½ years, which, together with his annual holiday, may mean his being absent from industrial employment for one month in every twelve until he is about twenty-five years of age.

Remembering, too, that the effects of the lower birth-rate will be strongly felt within the next decade, these national service requirements are bound to cause difficult problems for management in industry. It is essential, therefore, as Mr. Thomas points out, that the national service period should be used as efficiently as possible and should fit carefully into a scheme of training and experience, from school-leaving age to twenty-one or so, which will provide a useful apprenticeship to the responsibilities of work and citizenship. To offset the loss of industrial time, industry itself must make the best possible use of the time available in providing young people with specific training for their jobs. The rest of the article makes cogent suggestions for training schemes for various types of recruits and indicates how the difficulties of deferment for apprentices and students can be overcome.

U.N.E.S.C.O.: New Appointments

THE following new appointments in U.N.E.S.C.O. have recently been announced:

Dr. Clarence E. Beeby, director of education in the New Zealand Government, to be assistant director-general, concerned chiefly with the co-ordination of educational activities. Dr. Beeby, head of the New Zealand Delegation to the Second Session of the General Conference in Mexico City (November–December, 1947), was also chairman of the Programme and Budget Commission and thus is already well familiar with the aims and the activities of the Organisation.

Prof. Emile Auger, member of the French Atomic Energy Commission, to be head of the Natural Sciences Section. Prof. Auger was a member of the French Delegation to the General Conference of U.N.E.S.C.O. and has for the past year been a member of the Executive Board of the Organisation. He will replace Dr. Joseph Needham in that post. Dr. Needham, after nearly two years service with U.N.E.S.C.O., is returning to his post at the University of Cambridge.

Prof. Pedro Bosch Gimpera, to be director of the philosophy and humanistic studies section. Prof. Gimpera was formerly Dean of the Philosophy Department of the University of Barcelona. He has lately been professor in the University of Mexico.

Mr. Gordon Menzies (Australia), to be director of administrative services.

War-time Work of the American Academies

"THE ETHNOGEOGRAPHIC BOARD", by Wendell C. Bennett (*Smithsonian Misc. Coll.*, **107**, No. 1; 1947), is a history by one of its members of an organisation for harnessing the academic institutions of the United States to the war machine. It was set up by the National Research Council, the American Council of Learned Societies, the Social Science Research Council and the Smithsonian Institution in June 1942 and continued until the end of 1945. It was not an official body and it was financed and supported by the organisations which founded it, particularly the Smithsonian; but it was very largely used by the Armed Forces and Government departments, and is described as a "clearinghouse for Government needs and Academic knowledge". It consisted of a directorate, situated in the Smithsonian, which was the Washington office of the Board and did most of the work, and the Board proper, which was advisory. It produced reports on various areas, and lists of people with knowledge of foreign parts, and it undertook special projects, of which a booklet called "Survival on Land and Sea" was one of the most valuable and was widely circulated to the Armed Forces in the Pacific theatre. It had no equivalent in Great Britain, where the type of information supplied was collected by Service departments, such as the naval and military intelligence organisations and the Inter-Services Topographical Department.

Dr. Bennett gives a straight account of the Board and its activities, pointing out its strength and its weaknesses, and makes suggestions as to how such a body should be organised if needed again. (One of these is that it might have a better name!) Some points are of general interest, particularly the first paragraph on war-time Washington, beginning "For the millions who milled around Washington in the first half of 1942, no statement about the fabulous confusion could ever be adequate . . .", and the following statement about the search for people who

could compile special reports: "The Board found that those who were still in their academic settings managed to find time for something within their competence which was directly concerned with the war. Once a scholar was in Washington it was hard to get much out of him, and once he got into uniform, however sedentary the assignment, it was almost impossible."

Science and Society in Ancient China

In his Conway Memorial Lecture, "Science and Society in Ancient China", delivered on May 12, 1947, Dr. Joseph Needham attempts to sketch a pattern of the organisation of Chinese feudal society and its relation to Western European society (London: Watts and Co., Ltd. 2*s*. net). While the Taoist hermits who withdrew from human society to contemplate Nature had no scientific method, they tried to understand Nature in an intuitive and observational way, and the earliest chemistry and astronomy in Asia had Taoist connexions. In ancient China, although Taoist empirical mysticism favoured the development of science, Confucian ethical rationalism was antagonistic, and it could not be claimed that all through history rationalism had been the chief progressive force in society. While inventions and technological discoveries such as gunpowder, paper, printing, the magnetic compass and efficient animal harness, which changed the course of civilization, were made in China, modern science and technology did not develop them. Dr. Needham points out that the status of military technology may deeply affect the crystallization of social philosophy, and that a moral question such as slavery may be closely connected with technical factors. Philosophical and ethical thought, he believes, can never be dissociated from their material basis, and he thinks that Chinese civilization was basically inhibited from giving rise to modern science and technology, because the society which grew up in China after the feudal period was unsuitable for these developments. Dr. Needham concludes by commending a closer study of the great classics of Chinese philosophy and of the parallel course of technology in China.

Interchange of Technical Publications in Sheffield

A report on the progress made during the last year by the Organisation for the Interchange of Technical Publications in Sheffield was presented to the fifteenth annual general meeting held in the Central Library, Sheffield, on December 2. This Organisation controls a system of co-operative borrowing of books, periodicals and other records, between the numerous special libraries in the Sheffield area. Recent activities of the Organisation have been directed to other ways of assisting research and development now that the effective pooling of technical publications and information has been operating for many years. The annual report shows that 1,459 publications were borrowed last year. A survey of the location of foreign patents in British libraries was undertaken; through the Association of Special Libraries and Information Bureaux, the Patents Office was asked to close the gap in indexes and abridgments to British patent specifications left during the War; and an inquiry made as to the amount of assistance obtainable from the Nederlandsch Instituut voor Documentatie en Registratuur in foreign patent searches. At the annual general meeting, it was decided to ask the Board of Trade to have the mass of documents relating to war-time German industry held by the Technical Information and Documents Unit of the Board abstracted and indexed on similar lines to the work done in the United States by the Air Technical Intelligence and to have the more important items translated on the advice of technical experts. It was also recommended that files of the microfilms taken by the Board of machine drawings selected from this collection should be deposited with the leading technical libraries of Britain. Twenty-four firms and seven societies and institutions now belong to the Organisation.

Textile Laboratories at Leeds

The International Wool Secretariat has for the past ten years given increasing support to the University of Leeds for research on wool; it has now made a gift of £10,000 for the purchase of equipment for the new Textile Laboratories, all the apparatus to be utilized for the benefit of the wool industry. At present, five men hold Secretariat fellowships in the Department, and in addition, a grant of £1,600 a year has been made during the past two years in support of research in textile engineering. The number of workers engaged on these and other wool research projects is now so great that a severe strain has been thrown on the laboratory accommodation. In 1946, however, the Worshipful Company of Clothworkers of London made a grant of £20,000 towards the building of new wool research laboratories, and a start on the work was made in December 1947. The ground floor of the new building will be used to extend the Cloth Finishing Section of the Department, while the first floor will contain several laboratories for wool research workers. The second floor will take the form of one large laboratory, which will be used to give undergraduates practical experience of the applications of chemistry at all stages of the manufacture of wool textile materials. The grant of £10,000 from the International Wool Secretariat is for the equipment of the new building and will be used to purchase the most modern types of machinery for the Finishing Section, as well as the special apparatus which will be needed by research workers and undergraduates.

Old Scientific and Natural History Books

The following catalogues have been issued by Messrs. Bernard Quaritch, Ltd., of 11 Grafton Street, London, W.: No. 644, Books and Periodicals relating to Mathematics, Physics and Allied Sciences including two small collections on Accountancy and Mining; No. 650, Books and Periodicals on all Branches of Zoology, Geology, Palæontology and Botany; and a Catalogue of Books and Manuscripts issued to commemorate the One Hundredth Anniversary of the firm of Bernard Quaritch: 1847–1947. Noteworthy among these is Messrs. Quaritch's centenary catalogue. This is of especial interest to booklovers on account of the introductory matter, in which is related the growth of the firm from small beginnings in October 1847, in a shop in Castle Street, Leicester Square, London, to its present status as a business of world-wide repute. There is also a portrait of the founder, who died in 1899, and a brief sketch of his life, prepared by his daughter, Mrs. Charlotte Quaritch Wrentmore. As might have been anticipated, this catalogue is worthy of the occasion. It is a lavishly illustrated production, containing six coloured and some forty black-and-

white plates. Among more than two hundred books listed for sale there is a number of items of scientific interest, including the *editio princeps* of Pliny's "Historia naturalis", printed at Venice in 1469; a first edition of Newton's "Principia" (another copy is offered in Catalogue 644); an exceptionally fine copy of Hooke's "Micrographia"; and the first illustrated edition of the "Hortus Sanitatis", printed at Mainz in 1491. Many interesting works are listed in Catalogues 644 and 650, which contain 423 and 1,926 items, respectively.

Another catalogue of interest is that of Dr. E. Weil, c/o National Provincial Bank, 9 Market Place, London, N.W.11. This is No. 10, "From Alchemy to Chemistry and Pharmacology", and it includes also a section with sixty-nine works relating to the early history and development of photography. Among several works by or relating to Robert Boyle listed in this catalogue is Johann Seger von Weidenfeld's alchemical work "De Secretis Adeptorum" (London, 1684), in which the author made use of an unprinted manuscript by Boyle. Dr. Weil suggests that this manuscript, entitled "De Magisterio sive de investigatione secreti occulti Lullii", may be one of the Boyle manuscripts burned in 1688, of which, hitherto, no titles were known. This work, dedicated to Robert Boyle, will, it is stated, be described in Dr. J. F. Fulton's next addenda to his bibliography of Boyle.

Food Calories

THE Food and Agriculture Organisation of the United Nations has issued an interesting brochure entitled "Energy-Yielding Components of Food and Computation of Calorie Values" (from the Organisation, Washington, D.C.). This is the report of a Committee on Calorie Conversion Factors and Food Composition Tables, and contains much useful information. An appendix deals with organic acids as sources of available calories, and this includes a useful bibliography. The Committee considered the main causes of difference between estimates of energy-yielding components and of energy values, and concluded that the ideal procedure is separate determination of all the substances contained in food which contribute energy, combined with accurate assessment of their individual physiological values and their interrelationships. The question of the protein value of nitrogenous constituents is not completely resolved. Discussing carbohydrate values of foods, the Committee considers that at present the use of 'carbohydrate by difference' is justified, provided that its limitations are understood and appropriate procedures are used for deriving energy values. The value of the report cannot, however, be appreciated unless it is read.

Earthquakes during the Last Quarter of 1947

THE last quarter of 1947 opened with an earthquake on October 3 which was felt most strongly at Santarem, caused some alarm in the working-class districts of Lisbon, and damaged many buildings in Lisbon, Cascaes and Estoril. There were about ten other strong earthquakes in October in various parts of the world, including the one felt strongly at Coroni in southern Greece on October 6, and another felt strongly and causing some property damage 40 miles south-west of Fairbanks in Alaska on October 16. The latter had an aftershock on October 20. During this month, thirty-eight small earthquakes and earth tremors were felt in New Zealand, the greatest being on October 13 from an epicentre at lat. 44·2° S., long. 169·0° E., felt over most of the South Island. November opened with an intense earthquake on November 1, 150 miles north-east of Lima in Peru. This caused considerable property damage and also was responsible for the deaths of at least fifty-three people. Strong aftershocks of the earthquake occurred on November 7 and 25. Of the fourteen other strong earthquakes during the month, that on November 23 in south-west Montana was felt in Montana and Idaho. In December, some thirteen strong shocks occurred, the European ones being felt on December 13 in the Pyrenees, on December 20 in the Tirol and on December 25 at Lago d'Iseo in Italy. Seismological reports have been received from Beograd (Yugoslavia), Durham, Kew, United States Coast and Geodetic Survey and Jesuit Seismological Association, Strasbourg, Stuttgart, Wellington (New Zealand) and Zurich and the Swiss observatories.

International Conference on Sleeping Sickness

AT a conference convened jointly by the French, Belgian and British Colonial authorities and recently held at Brazzaville, French Congo, to which the Governments of Portuguese territories in Africa, of Southern Rhodesia and the Union of South Africa also sent delegates, arrangements were made for the uniform mapping of the whole of Africa south of the Sahara to show the incidence of trypanosomiasis in man and domestic animals and of the various species of tsetse fly which transmit it. It was also agreed to establish, at Brazzaville and Leopoldville, a joint bureau for the rapid exchange of information on methods of controlling the disease, and to set up in Europe a scientific committee on an international basis to supervise the organisation of research. These conclusions will now be forwarded to the Governments of all the African territories as recommendations for a concerted effort to control the disease and to work towards its gradual elimination.

Society of Chemical Industry: Annual General Meeting

THE Society of Chemical Industry will hold its annual general meeting in Edinburgh during July 12–17. This is the first annual general meeting since the War to be held outside London, and the first since 1927 to be held in Edinburgh. The president of the Society, Dr. L. H. Lampitt, chief chemist and a director of Messrs. J. Lyons and Co., Ltd., will deliver his address on July 13. On July 14 there will be a lecture by Sir John Anderson, who has been awarded the Messel Medal for 1948 of the Society. The Lister Memorial Lecture will be given on July 15. This Lecture was founded to commemorate the influence of the work of the late Lord Lister on the pharmaceutical industry in Edinburgh and was endowed in 1944 by two Edinburgh firms of drug and fine chemical manufactures, Messrs. J. F. Macfarlan and Co. and Messrs. T. and H. Smith, Ltd. The first lecturer, in 1944, was Sir Alexander Fleming. This year's Lecture will be devoted to biochemistry. A series of papers will be presented dealing with industrial chemical aspects of a number of the principal industries in the east of Scotland. They will describe some of the industrial research which has already been done in Scotland and will point to the possibilities for the future. In many cases the lectures will be followed by visits to the factories and installations of the various industries. Lectures will be given by Prof. S. Watson, principal of the East of Scotland

College of Agriculture; Dr. G. A. Reay, of the Torry Research Station, Aberdeen; Mr. E. R. H. Edge, of Messrs. Alex. Pirie and Co., Aberdeen, on paper-making; Prof. W. H. Melville, of the University of Aberdeen, on rubber; Dr. I. A. Preece, of the Heriot-Watt College, Edinburgh, on brewing; and Mr. H. Corteen, director of the British Jute Trade Research Association of Dundee, will speak on "Research Developments and Applications to Textile Industries in East Central Scotland". The meeting is being organised by the Edinburgh and East of Scotland Section of the Society, the honorary secretary of which is F. J. Bolton, 17 Wester Coates Avenue, Edinburgh 12.

International Conference on Powder Metallurgy

THE Steirmark Branch of the Association of Austrian Chemists is arranging an International Powder Metallurgy Conference to be held during July 12–16 in Graz. It is hoped, by lectures and discussions, to furnish a comprehensive picture of the position and problems of the scientific, industrial and economic aspects of powder metallurgy and allied subjects. The organising committee consists of Prof. G. Jantsch, Technische Hochschule, Graz; Dr. R. Kieffer, Metallwerk Plansee, Reutte, Tirol; Prof. O. Kratky, Universität, Graz; Prof. G. F. Hüttig, Technische Hochschule, Graz. Further information can be obtained from Dr. C. Sykes, Brown – Firth Research Laboratories, Princess Street, Sheffield; or Mr. M. Littman, Compound Electro Metals, Ltd., 42 Pall Mall, London, S.W.1.

International Sericultural Congress

THE Seventh International Sericultural Congress will be held at Alès (Gard) in the Cevennes during June 7–13, and will be followed by an International Silk Congress at Lyons. The Sericultural Congress is being organised by the French National Institute of Agronomic Research; the president is Prof. R. Delmas, professor of sericulture in the École Nationale d'Agriculture, Montpellier, and the general secretary is M. Schenk, director of the Sericulture Research Station, Alès. The programme is being arranged in a number of sections covering scientific, economic and technical aspects of the subject. The Congress, which will mark the fiftieth anniversary of the research station at Alès, will be the first of so wide a scope since the Sixth International Sericultural Congress held in Paris during September 1878. Further particulars can be obtained from the Secrétariat-Général, Station de Recherche Séricoles, 28 Quai Boissier de Sauvages, Alès (Gard), France.

Conference on Rheology and Textiles

A CONFERENCE on "Rheology in the Textile Industries" has been arranged by the British Rheologists' Club in association with the Textile Institute, the Society of Dyers and Colourists, the Leeds area local sections of the Chemical Society and the Royal Institute of Chemistry, the Yorkshire Section of the Society of Chemical Industry and the Manchester and District Branch of the Institute of Physics, and will be held during March 19–20 in the Department of Textile Industries, University of Leeds. Further particulars can be obtained from Prof. J. B. Speakman, University, Leeds 2, or the honorary secretary of the British Rheologists' Club, Dr. E. W. J. Mardles, Royal Aircraft Establishment, Farnborough, Hampshire.

Announcements

AT a recent ceremony at the Royal Netherlands Embassy, London, the Netherlands Ambassador presented the insignia of Commander in the Order of Orange-Nassau (Civilian Division) in recognition of services rendered to the Netherlands during the War to the following, among others: Sir George Beharrell, chairman of the Dunlop Rubber Co., Ltd.; Sir Jack Drummond, sometime scientific adviser to the Ministry of Food; Dr. John Hammond, reader in agricultural physiology, University of Cambridge; Sir Raymond Streat, chairman of the Cotton Board.

THE following appointments in the University of Leeds have been announced: Prof. H. S. Ruse, professor of pure mathematics, to be head of the Department of Mathematics on the retirement of Prof. S. Brodetsky at the end of the present session; Prof. T. G. Cowling, professor of mathematics at the University College of North Wales, Bangor, to be professor of applied mathematics from October 1; Dr. N. H. Hartshorne, to be lecturer in chemical microscopy.

THE following appointments in the University of Sheffield have been announced: Dr. A. J. Gould, senior lecturer in the Department of Glass Technology; Dr. J. S. D. Bacon, lecturer in biochemistry; R. E. Davies, honorary lecturer in biochemistry; A. Jordan, honorary lecturer in clinical biochemistry.

A SYMPOSIUM on "Combustion and Flame and Explosion Phenomena" will be held at the University of Wisconsin during September 7–11. Papers will be presented on fundamental and theoretical aspects of combustion, technical research, combustion problems in jet propulsion, special fuels, etc. It is hoped to publish all the papers together within a few months of the meeting. Particulars can be obtained from Prof. Joseph O. Hirschfelder, University of Wisconsin, or from Dr. Bernard Lewis, U.S. Bureau of Mines, Pittsburgh 13, Pennsylvania.

THE Faraday Society is arranging one of its General Discussions, which will be held in the Department of Physics, University College, Southampton, during March 31–April 2. The subject will be "The Interaction of Water and Porous Materials", and the papers have been divided into four groups: (1) Fundamental Aspects; (2) Botanical Aspects: Mechanism of Movement of Solutions in Plants; (3) Zoological Aspects: Water-Protecting Properties of Cuticles; and (4) Permeability to Water and Water Vapour of Textiles and other Fibrous Materials. Papers will be issued in advance of the meeting and taken as read. Further particulars can be obtained from the Faraday Society, 6 Gray's Inn Square, London, W.C.1.

THE British Iron and Steel Research Association has now obtained a licence for erecting limited accommodation of temporary construction on a site at Meadow Street in Sheffield. At the present time the Association's investigations at Sheffield are divided between the Applied Science Department of the University of Sheffield (where there is an experimental rolling mill), the works of Arthur Lee and Sons, Ltd. (where there is a prototype backpull wire drawing machine), and elsewhere. The intention is ultimately to create a permanent building in which rolling, drawing and other similar researches will be centralized.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Formation of Derivatives of Thyroxine from Derivatives of Diiodotyrosine

THE observation of von Mutzenbecher[1] that traces of thyroxine are formed on incubation of an alkaline solution of diiodotyrosine was developed by Harington and Pitt Rivers[2]. These authors showed that the course of the reaction was greatly influenced by *p*H; the largest yield of thyroxine, amounting to 2·7 per cent calculated on the diiodotyrosine not recoverable at the end of the oxidation, was obtained at *p*H 10; at this *p*H the acidic groups of diiodotyrosine are 95 per cent neutralized. In highly alkaline solution, there was little destruction of diiodotyrosine and no thyroxine formation: at lower alkalinity (*p*H 8–9) the destruction of diiodotyrosine was very extensive and the formation of thyroxine was minute. In all experiments in which diiodotyrosine was oxidatively destroyed, tarry by-products appeared and the liberation of ammonia was evident.

It seemed reasonable to suppose that protection of the amino-group of diiodotyrosine by acylation would diminish the tendency towards oxidative destruction of the amino-acid, and might then favour the oxidative intramolecular coupling which is the essential step in thyroxine formation. As a preliminary test of this hypothesis, solutions of *N*-acetyl-*l*-diiodotyrosine were incubated at 37° for fourteen days, the *p*H varying from 6·5 (60 per cent neutralization) to 8·5 (90 per cent neutralization). At the end of the incubation, the solutions were made strongly alkaline and boiled under reflux to hydrolyse the acetamino-group; butanol separation then led to the isolation of thyroxine. The amounts of thyroxine formed were small, the maximum formation occurring at *p*H 7·5.

It had been noticed that during these incubations a white crystalline salt slowly separated. In a further experiment at *p*H 7·5, this salt was collected after fourteen days. After decomposition with acid and purification of the product by the method of Ashley and Harington[3], there was obtained *N-acetyl-l-thyroxine*, m.p. 227–228° (decomp.), $[\alpha]_D^{25}$ 25·7° (c = 4 per cent in a mixture of equal volumes of alcohol and *N* sodium hydroxide). Hydrolysis of this compound by heating with a mixture of 15 parts concentrated hydrochloric acid and 25 parts of acetic acid yielded *l*-thyroxine, $[\alpha]_D^{25}$ −5·42° (c = 3·3 per cent in a mixture of 2 parts alcohol and 1 part *N* sodium hydroxide); found: I, 62·0 per cent; $C_{17}H_{13}O_4NI_4$ requires I, 62·0 per cent. The yield of acetylthyroxine calculated on the acetyldiiodotyrosine destroyed was 15–20 per cent.

These experiments showed clearly that the reaction of oxidative coupling of two molecules of diiodotyrosine to form a diphenyl ether is not confined to the free amino-acid, but on the contrary is favoured by acylation of the amino-group; moreover, with the acylamino-derivative the coupling occurs most readily at the *p*H of body tissues. In view of the obvious bearing of this result on the question of the formation of thyroxine in natural proteins, it was desirable to extend the experiments to a derivative of diiodotyrosine in which both amino- and carboxyl-groups were blocked. The derivative selected was *N*-acetyl-*dl*-diiodotyrosylglutamic acid.

A preliminary incubation of this compound at *p*H 7·2, followed by hydrolysis and butanol fractionation, did indeed lead to thyroxine formation; but in this case no insoluble sodium salt separated and the ultimate yield was low. The experiment was therefore repeated at the same *p*H in baryta solution; under these conditions a barium salt soon began to separate and increased in amount until a month had elapsed. At this time it was collected and decomposed with acid, and the product crystallized from aqueous methanol. The *N-acetyl-dl-thyroxylglutamic acid* thus obtained formed fine needles, m.p. 195–200° (decomp.); found: C, 27·8; H, 2·77; I, 52·5 per cent; $C_{17}H_{17}O_8NI_4$, H_2O requires C, 27·3; H, 2·3; I, 52·6 per cent. Hydrolysis of this compound with a mixture of acetic and hydrochloric acids yielded pure *dl*-thyroxine and glutamic acid. The yield of *N*-acetyl-*dl*-thyroxylglutamic acid was 36 per cent after allowing for recovered starting material. It is clear, therefore, that combination in peptide linkage of the carboxyl group of diiodotyrosine favours still more its conversion at biological *p*H into thyroxine.

In the experiments just described, the final reaction mixture is relatively free from tarry by-products; it is therefore hoped that it may be possible to isolate an acylamino-compound corresponding to the side-chain lost from one of the molecules of diiodotyrosine participating in thyroxine formation; attempts in this direction are now in progress.

A full account of the work described above will be published elsewhere.

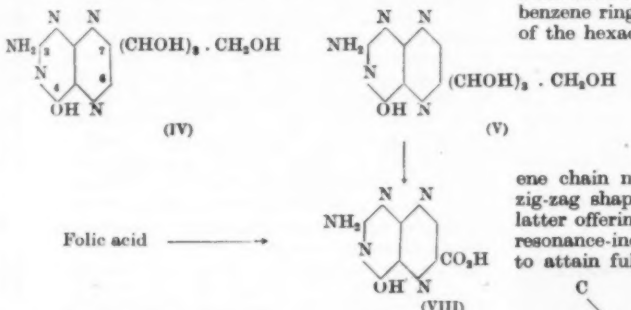
ROSALIND PITT RIVERS
National Institute for Medical Research,
London, N.W.3.
Dec. 3.

[1] von Mutzenbecher, P., *Z. Physiol. Chem.*, **261**, 253 (1939).
[2] Harington, C. R., and Pitt Rivers, R. V., *Biochem. J.*, **39**, 157 (1945).
[3] Ashley, J. N., and Harington, C. R., *Biochem. J.*, **23**, 1178 (1929).

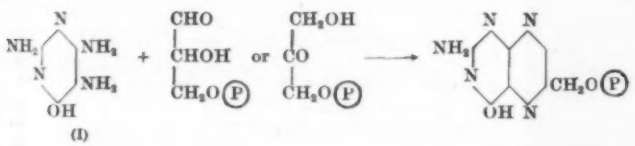
Condensation of 2 : 4 : 5-Triamino-6-hydroxypyrimidine with Glucose and Fructose

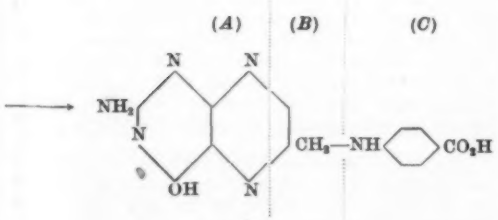
WE have been engaged for some time on a study of the condensation of 2 : 4 : 5-triamino-6-hydroxypyrimidine (I) with glucose and with fructose. As Ohle and Hielscher[1] have carefully established the optimal conditions for the condensation of *o*-phenylenediamine with glucose and with fructose in the preparation of tetrahydroxybutylquinoxaline, we have, from the outset, applied these conditions to (I). Glucose afforded a product (II) having $[\alpha]_D^{20°}$ approximately − 81·5° in *N* hydrochloric acid or in *N*/10 sodium hydroxide solution, while fructose afforded a substance (III) with a slightly higher specific rotation, $[\alpha]_D^{20°}$ approximately − 86·6°, under the same conditions. At this point, a paper by Karrer, Schwyzer, Erden and Siegwart[2] appeared describing the condensation of (I) with a variety of simple sugars using less elaborate conditions than ours. Their product from glucose had $[\alpha]_D^{20°}$ − 68·93°, and their product from fructose had $[\alpha]_D^{20°}$ − 46·0°, respectively, in *N*/10 sodium hydroxide solution; these figures are significantly different from ours, particularly in the case of the product from fructose. Although final conclusions were not reached, Karrer and his collaborators considered their products from glucose and fructose to be respectively (IV, or V ?) and (V, or IV ?), the constitution of their product from glucose being indicated as (IV) with some degree of certainty.

The lack of concordance between the respective specific rotations recorded by the Swiss authors and our own observed values led us to repeat our own work, and we have fully confirmed our own observations. In spite of the slight difference in the optical rotations of (II) and (III), we are of the opinion that our products (II) and (III) are substantially the same compound, 2-amino-4-hydroxy-6-*d*-*arabo*tetrahydroxybutylpteridine (V), for the following reasons. On oxidation with periodic acid, (II) and (III) afforded aldehydes yielding acids (VI) and (VII) on further oxidation. The acids (VI) and (VII) were shown to be identical with 2-amino-4-hydroxypteridine-6-carboxylic acid (VIII), which we obtained by aerobic alkaline hydrolysis of folic acid[3], and distinct from 2-amino-4-hydroxypteridine-7-carboxylic acid (IX), which we obtained by oxidation of 2-amino-4-hydroxy-7-methylpteridine[4], by their ultra-violet absorption spectra in alkaline solution. Furthermore, the sodium salts of (VI), (VII) and (VIII) in aqueous solution all showed the same intense sky-blue fluorescence, while that of (IX) showed a bright green fluorescence in ultra-violet light.



While discussing pteridines and sugars, it is engaging to consider the possible biogenesis of pteroic acid (X). (X) can be regarded as being composed of three fragments, (*A*) being common to (X) and to guanine, (*B*) being a triose, and (*C*) being *p*-aminobenzoic acid. The triose could be either 3-phosphoglyceraldehyde or phosphodihydroxyacetone; both are theoretically capable of participating in oxidative ring-closures of the type discussed in the present communication, and the direct alkylation of aromatic amines with (*ortho*)phosphoric esters is an established reaction[5].





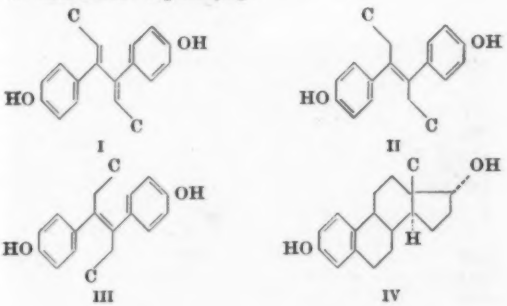
A full account of this work will be published elsewhere.

H. S. Forrest
James Walker
National Institute for Medical Research,
Hampstead, London, N.W.3. Oct. 22.

[1] Ohle, H., and Hielscher, M., *Ber. deutsch. chem. Ges.*, **74**, 13 (1941).
[2] Karrer, P., Schwyzer, R., Erden, B., and Siegwart, A., *Helv. chim. Acta*, **30**, 1031 (1947).
[3] Stokstad, E. L. R., *et al.*, *Ann. N.Y. Acad. Sci.*, **48**, Art. 5, 269 (1946).
[4] Mowat, J. H., *et al.*, *Ann. N.Y. Acad. Sci.*, **48**, Art. 5, 279 (1946).
[5] Billman, J. H., Radike, A., and Mundy, B. W., *J. Amer. Chem. Soc.*, **64**, 2977 (1942). Thomas, D. G., Billman, J. H., and Davis, C. E., *ibid.*, **68**, 895 (1946).

Configuration of Synthetic Œstrogens

It has recently been shown[1] by a consideration of the molecular resonance properties associated with various structural models that the observed[2] centrosymmetrical nature of the hexadiene-œstrol molecule (*pp'*-dihydroxy-3 : 4-diphenyl-2 : 4-hexadiene) [I] requires the hexadiene chain to exist in the planar *trans-trans*-configuration shown below. The two benzene rings are probably rotated by some 50° out of the hexadiene plane in order to reduce the steric interference of the *ortho* hydrogen atoms. Similar arguments lead to a non-coplanar structure of stilbœstrol (*pp'*-dihydroxy-αβ-*trans*-diethylstilbene [II], in which the conformation of the aliphatic hexene chain must be expected to approximate to a zig-zag shape rather than to the *S*-form [III], the latter offering much greater steric opposition to the resonance-induced tendency of the stilbene skeleton to attain full coplanarity.



In connexion with the high physiological potencies of stilbœstrol and its analogues, there has been a tendency to draw an analogy between the 'paper' structure [III] and the established arrangement of the nuclear carbon atoms in the molecule of the natural œstrogenic hormone 'α'-œstradiol [IV]. This analogy appears to have no basis in fact, and must not be regarded as a clue to the actual configurations of the synthetic œstrogenic molecules, which are more correctly represented in two dimensions by [I] and [II].

H. P. Koch
British Rubber Producers' Research Association,
48 Tewin Road, Welwyn Garden City,
Herts. Nov. 13.

[1] Jeffrey, Koch, and Nyburg, *J. Chem. Soc.* (in the press).
[2] Carlisle and Crowfoot, *J. Chem. Soc.*, 6 (1941).

A Polysaccharide from Hydatid Cyst Fluid

A SEROLOGICALLY active polysaccharide has been isolated from hydatid cyst fluid from an infested sheep. A positive precipitin reaction was obtained with the serum from a patient suffering from pulmonary hydatid disease, when dilute solutions of this polysaccharide were used as an antigen. Serum giving positive and negative Wassermann results showed no precipitin reaction with this same antigen.

It is considered that this polysaccharide fraction of the hydatid cyst fluid is probably the specific antigenic factor.

A detailed report of the preparation of this fraction together with its properties will be submitted for publication at a later date.

GWEN M. MACNAB
South African Institute for Medical Research,
Johannesburg.
Nov. 1.

Gas Discharges at Centimetre Wave-lengths

EXPERIMENTS have recently been described[1] showing that at frequencies of 2,800 Mc./sec. and 9,800 Mc./sec. the breakdown of air takes place at stresses some 30 per cent lower than the breakdown values for steady voltages, for gaps of a few millimetres. In order to extend the observations to longer gaps, experiments are in progress on discharges in cavity resonators, where the necessary stress can be built up over longer gaps. Power is obtained from a magnetron excited by 1 microsecond pulses applied either individually or at the rate of 400 per second.

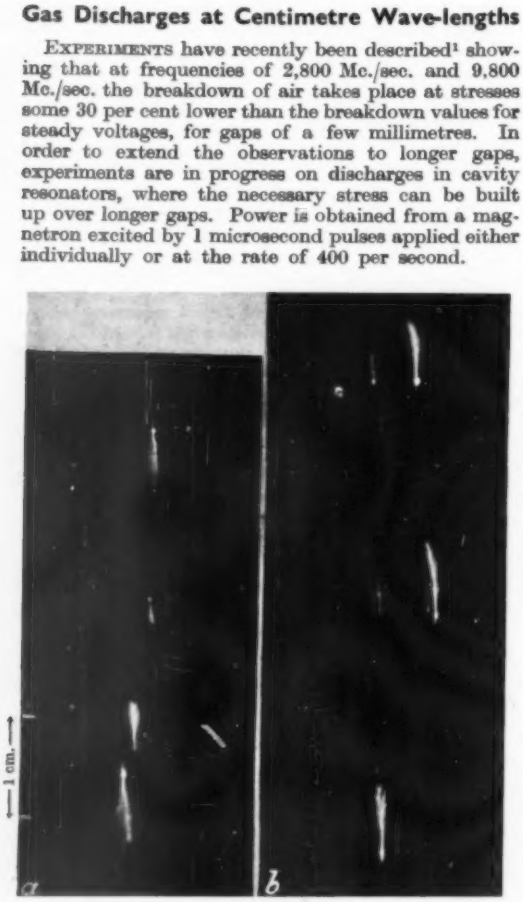


Fig. 1. PHOTOGRAPHS OF DISCHARGES IN A RESONATOR (*a*) WITHOUT IRRADIATION; (*b*) ONE ELECTRODE IRRADIATED WITH ULTRA-VIOLET LIGHT

The film was moved between successive discharges. Note that in (*b*) the discharge always starts from the same electrode and that subsidiary streamers are present. Electrode separation 1·44 cm.

The form of discharge obtained at atmospheric pressure is shown in Fig. 1, where it will be seen that the chief component consists of a bright spot on the electrode, together with a less intense tail across part of the gap. With repetitive operation, the gap is filled with a faintly luminous haze in addition. Occasional mid-gap streamers are observed for both individual and repeated pulses. Spectrographic observations show that the tail emits a nitrogen band spectrum, while the spot emits lines characteristic of the electrode material.

With 400-cycle pulses, as the pulse voltage is lowered, the time-interval between bursts of discharge increases and it is possible to determine graphically the pulse voltage V_0 for which the probability of starting the discharge becomes zero. For any pulse voltage greater than V_0, it is found that if sufficient *individual* pulses are applied a discharge eventually occurs, so that the breakdown voltage of the gap is the same for individual and for repeated pulses. Once, however, a discharge has occurred, the probability of breakdown within 1/400 sec. is increased, so that the 400-cycle pulses produce bursts of discharge, and a direct comparison of the ratio (No. of discharges)/(No. of pulses) for repeated and for individual pulses cannot be made.

Initial experiments, in which ultra-violet light from an auxiliary spark was applied immediately before the beginning of the high-frequency pulse, showed that ultra-violet light has marked effects on the appearance of the discharge, and on the sparking probability, for single pulses. A comparison between the sparking probabilities, with and without irradiation, can be made directly. In agreement with earlier work[1], in which a radium source was employed, it is found that the voltage at which the sparking probability just becomes zero—the true breakdown voltage—is unaffected by irradiation: at higher voltages irradiation increases the sparking probability.

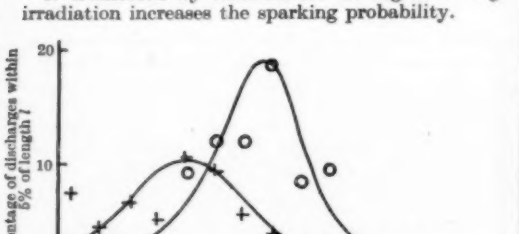


Fig. 2. DISTRIBUTION OF LENGTH OF DISCHARGES
○, one electrode illuminated with ultra-violet light; +, no irradiation

When the electrode surface is irradiated, the length of the luminous tails is increased, and shows less variation from pulse to pulse (Fig. 2). When, however, the ultra-violet light is concentrated in the gas (air) between the electrodes, numbers of mid-gap streamers are observed at each pulse, even when the typical spot and tail discharge does not occur—clearly a consequence of photo-ionization in the gas.

The observations are being extended to include an examination of the effect of changes in the duration of the pulse, the nature of the gas and the gas pressure on the discharge phenomena. It is hoped

also to make cloud-chamber studies of the conditions preceding breakdown.

Grateful acknowledgment is made to the Council of the Durham Colleges for granting one of us (W. A. P.) a year's leave to pursue this work, and to the British Electrical and Allied Industries Research Association for financial support throughout the investigation.

W. A. Prowse
R. Cooper

Electrical Engineering Dept.,
Imperial College,
London, S.W.7.
Nov. 11.

[1] Cooper, R., *J. Inst. Elect. Eng.*, **94**, Pt. 3, 315 (Sept. 1947).

Refraction Effects in Electron Diffraction and in Electron Microscopy

Recently, Cowley and Rees[1] reported some interesting work on the fine structure of electron diffraction patterns of crystals of magnesium oxide, cadmium oxide, etc. (multiple rings or spots) by application of high-resolution electron diffraction cameras. They confirmed the view of Sturkey and Frevel, who suggested that this fine structure arises from refraction at the faces of the regularly shaped crystal cubes. If the normals of the faces by which the beam of electrons enters and leaves the crystal lie in the same plane with the beam and the normal of the net plane[2], one can derive an expression relating the angular displacement of the beam ε to the angles φ_1 and φ_2 (angle between face normal and incident and refracted electrons respectively):

$$\varepsilon = \theta - \theta_0 = \varepsilon_1 + \varepsilon_2 = V/2E(\pm\tan\varphi_1 \pm \tan\varphi_2) \qquad \theta < \varphi < \pi/2 - \theta \qquad (1)$$

(V is inner potential, E is accelerating potential, θ_0 Bragg angle for $V = 0$). This deviation having values of 10^{-4} radians ($V = 10$ volts, $E = 50{,}000$ volts, $\varphi = 45°$) or 3×10^{-3} cm. at a specimen-plate distance of 30 cm., high resolution will be necessary to detect it.

This explanation is intimately connected with that given for the results obtained with electrolytically polished surfaces (Jacquet procedure) by electron diffraction and the electron microscope[3]. These surfaces are slightly waved so that the angle between the limiting face and the net planes (δ) has only a value of some degrees, whereas in the case considered above the faces are steeply inclined to the net planes. Therefore ε becomes greater and the same refraction effect will be observed by normal resolution.

Thus $\varepsilon = (\tan\delta + \theta_0)\left[\begin{matrix}+\\(-)\end{matrix}\sqrt{1 - \frac{V}{E(\tan\delta + \theta_0)^2}} - 1\right]$

($\sin\theta \sim \theta$, $\sin\theta_0 \sim \theta_0$). Generally, one can put $V/E < (\tan\delta + \theta_0)^2$ also for electrolytically polished surfaces. Thus it follows

$$\theta = \theta_0\,(1 - V/2E\theta_0^2\,(1 + \tan\delta/\theta_0))\,[4] \quad \text{or}$$

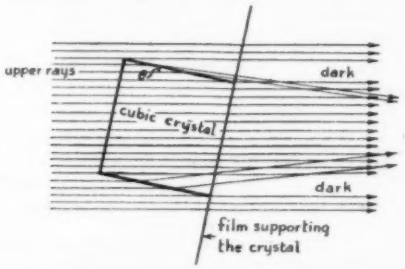
$$\varepsilon = -\,V/2E(\tan\delta + \theta_0). \qquad (2)$$

With $\delta \sim 5 \times 10^{-2}$ (3°) and $\theta_0 \sim 2 \times 10^{-2}$, one finds $\varepsilon \sim 15 \times 10^{-4}$, or half a millimetre at a plate-specimen distance of 30 cm., which can be seen without difficulty, $\tan\delta$ being always greater than 0 in the case of reflexion (there are always elevations transmitted), ε will be less than 0, or the reflected beam is displaced to smaller reflexion angles. If δ is continuously varying between 0 and δ_{max}, the patterns are enlarged to streaks as on electrolytically polished surfaces. For transmission patterns as referred to above, one has also $\tan\delta < 0$ and therefore $\theta > \theta_0$.

Between the angles φ, θ and δ exists the relation $\delta = \pi/2 - (\varphi + \theta)$. To show the transition from eq. 2 to eq. 1, one has to put $\varphi > 0$ as supposed for the derivation of (1), and one obtains

$$\varepsilon = -\,(V/2E)\tan\varphi.$$

The total deviation is given by the sum of ε at entering and leaving the faces.



These considerations are also relevant to refraction effects in electron microscopy. A refraction effect may be of importance if well-shaped crystals, for example, cubic crystals, are transmitting electrons as shown in the diagram. The electrons being deflected by refraction out of their original direction, one would expect that the cube faces nearly parallel to the beam would appear as dark lines (a dark frame if the crystals are also somewhat tilted with their faces out of the plane of the paper). The refraction by the steeper faces is here neglected. Whether the refracted image is visible or not depends on the objective aperture and the inclination of the crystal. It seems to me that the dark bands which surround small inclined crystals of magnesium oxide[5] may be explained in such a manner. The size of these bands is given by the crystal dimensions in the primary direction and the angle of inclination.

At very small angles ($\theta \leqslant \theta_{lim} = \sqrt{V/E} = 0{\cdot}014$ at $V = 10$ volts and $E = 50{,}000$ volts) the rays, in the figure the 'upper rays', are totally reflected, which gives as above a transmitted (dark) and a totally reflected (intense) image, the latter being more deflected (2θ) than that normally refracted. Perhaps this effect would be found by a systematic study using crystals of greater dimensions, for which the bands are better resolved.

H. Raether

Laboratoires de l'O.N.E.R.A.,
Paris.
Sept. 16.

[1] Cowley and Rees, *Proc. Phys. Soc.*, **59**, 288 (1947). *Nature*, **158**, 550 (1946). See also Sturkey and Frevel, *Phys. Rev.*, **68**, 56 (1945) and Hillier and Baker, *Phys. Rev.*, **68**, 98 (1945).

[2] If this condition is not fulfilled one has to take a more general formula derived by Cowley and Rees (ref. 1).

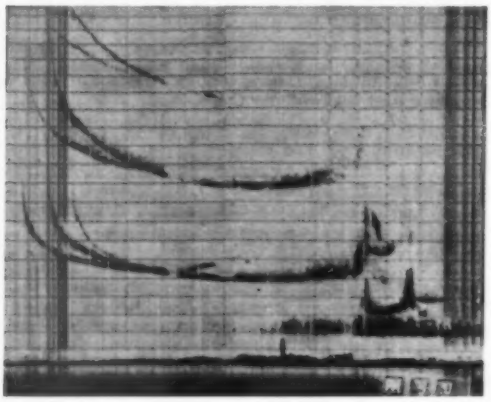
[3] Raether, H., *Métaux et Corrosion* (Jan. 1947).

[4] Kranert, W., Leise, K. H., and Raether, H., *Z. Phys.*, **122**, 248 (1944). In this paper the formula given for θ was $\theta = \theta_0\sqrt{1 - V/E\theta_0^2\,(1 + \tan\delta/\theta_0)}$, which had been derived by putting approximately $\theta + \theta_0 = 2\theta_0$: developed, it gives the exact solution 2. They are equivalent in the regions applied for the evaluation of electrolytically polished surfaces.

[5] For example, Heidenreich, R. D., and Sturkey, *J. App. Phys.*, **16**, 97 (1945), Fig. 1. Kinder, E., *Naturwiss.*, **31**, 149 (1943). This effect must not be confused with the parallel strips of strongly inclined crystals the origin of which explains the dynamical theory, nor with the Fresnel diffraction strings in the out-of-focus image of a crystal edge.

Triple Magneto Ionic Splitting of Rays Reflected from the F_2 Region

A RECORD for 1700 hr. local time on November 9, 1946, from the Hobart *P'f* recorder operating in the frequency range 1·5–13 Mc./s. is reproduced below.



The record shows the ordinary and extraordinary rays usually present from F_2 with critical frequencies of 7·6 and 8·5 Mc./s. respectively, as well as a third ray the critical frequency of which is 7·0 Mc./s. The critical frequencies of these rays correspond approximately to the Appleton–Hartree[1] reflexion condition $\mu = 0$ except that, neglecting collision, one would expect the third ray to have a critical frequency of 6·7 Mc./s. Discrepancies of about this magnitude and sign which are not ascribable to experimental error occur in all the 'triple split' measurements taken and may perhaps be accounted for if collision effects were included in the calculations. The possible existence of triple magneto ionic splitting in a layer where the variation of electron density with height is very rapid was first discussed by Mary Taylor[2], and the phenomenon has been observed by Toshniwal[3] and Liev Harang[4]; but the record shown is one of the best examples of it that we have seen.

Thirty-nine definite examples of this triple splitting have been observed in some 50,000 records spaced at regular intervals over a period of a year. Other records possibly showing this effect (quadruple and even higher multiple forking) have been discounted as examples of multiple magneto ionic splitting because of indications of stratification in F_2 or very spread echoes. The triple split records are generally accompanied by sporadic *E* ionization and seem more likely to occur under disturbed conditions. Triple splits have been observed at nearly every hour of the day, but they occur most frequently between the hours of 1700 and 2000. Occasionally they appear on the records over a period of several hours, starting or finishing as multiple forked records in the stratified layer. There appears on the Hobart data to be no evidence for the seasonal variation noticed by Harang. The figures for the number of occasions present (they may be either single occurrences or last for several hours) over twelve months are: 1946, September 2, October 4, November 3, December 0; 1947, January 0, February 3, March 5, April 1, May 0, June 2, July 5 and August 4. Further data on the occurrence of the phenomena will be analysed as they become available.

The records from the Hobart *P'f* recorder are measured by the University of Tasmania for the Radio Research Board of the Council of Scientific and Industrial Research, and I would like to acknowledge the help received from that body in this and other ionosphere investigations.

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Nov. 5.

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Variable Source of Radio Frequency Radiation in the Constellation of Cygnus

COSMIC or galactic noise was discovered by Jansky[1] in 1931; but its exact origin has remained uncertain. It is generally supposed to originate from collisions in interstellar matter[2]; but there are divergencies between existing theory and experimental results, particularly at lower radio frequencies[3]. Hey, Parsons and Phillips[4] discovered variations in the intensity of galactic noise from the direction of the constellation of Cygnus, with a period of about one minute—suggesting that this particular radiation has its origin in a discrete source.

During the past three months, we have made a study of this region, mainly on 100 Mc./s., but also occasionally on 60, 85 and 200 Mc./s. The technique employed was to observe the region rising over the sea with aerials situated on a high cliff, as described by Pawsey, Payne-Scott and McCready[5]. Due to interference between the direct ray and the ray reflected from the sea, a lobe pattern is obtained which gives rise to a succession of maxima and minima. An estimate of the size of the source can be made from the relative heights of maxima and minima, and an accurate position found from the times of occurrence of minima.

Small aerial arrays were used—one or two Yagis—and considerable care was taken with receiver stabilization enabling receiver noise to be balanced out and the input signal amplified for presentation on a recording milliammeter. At 100 Mc./s. receiver fluctuations represented an input signal of less than 3×10^{-24} watts m.$^{-2}$(c./s.)$^{-1}$.

The general results of our investigations are:

(1) The variations from Cygnus originate in an area of less than 8′ angular width. This is an upper estimate and the source may well be effectively a point.

(2) The location of the source is R.A. 19 hr. 58 min. 47 sec. ± 10 sec. Dec. +41° 41′ ± 7′.

(3) The radiation consists of two components, one constant and the other showing considerable variation over short and long periods. In Fig. 1, a typical record of the source rising, the two components are separated by a dotted line. A record of the 'quiet' sun rising is shown for comparison in Fig. 2. The frequency in both cases was 100 Mc./s.; intensity scales are the same on both records.

(4) Observation on different frequencies shows that the intensity of the constant component has a shallow

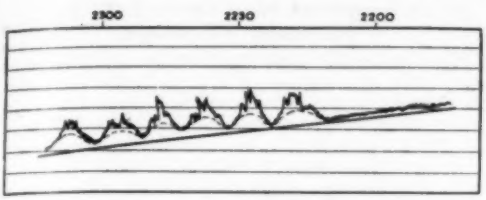

Fig. 1. Record of source in Cygnus rising

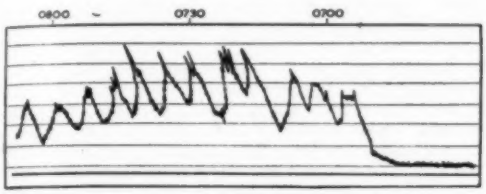

Fig. 2. Record of 'quiet' sun rising

peak in the region of 100 Mc./s., whereas that of the variable component increases rapidly with decreasing frequency. No variable component has so far been detected on 200 Mc./s.

(5) The periodicity of the variations decreases with decreasing frequency. No close correlation has been found between short-period variations on frequencies as close as 85 and 100 Mc./s., but the general activity of the variable component shows good correlation on different frequencies.

The determined position does not coincide with any outstanding stellar object, but is close to two seventh magnitude stars. It is notable that Hey[6] and Moxon[7] found a secondary maximum of galactic noise in Cygnus. The present evidence indicates that the noise from this region comes from a discrete source superimposed on a smooth continuum.

Taking the size of the sources as less than 8′, the constant component represents an effective temperature of more than 4×10^6 degrees Kelvin at 100 Mc./s., which makes a thermal origin of the noise doubtful. A mechanism similar to that proposed by Martyn[8] to account for enhanced solar radiation on metre wave-lengths (association of moving ionized matter and magnetic fields) may account for the phenomenon, though further evidence is required to throw more light on the problem.

Our thanks are due to Dr. J. L. Pawsey for his help and encouragement during this work, which is part of the programme of the Radiophysics Laboratory of the Council for Scientific and Industrial Research. Full details are being published elsewhere.

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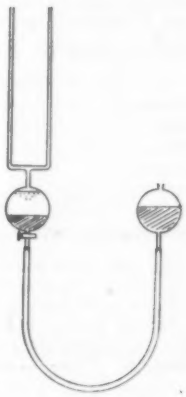
Particle-size Measurement

I have recently had occasion to devise a scheme for measuring the mean diameters of the particles of a powder. The method finally evolved has not been discovered during an examination of the available literature, and in view of its simplicity seems to merit description.



The essential features of the apparatus are shown in the diagram, the vertical limbs of the U-tube being in this case about 0·1 sq. cm. in area. A non-polar 'wetting' liquid such as carbon tetrachloride is floated on mercury in the reservoir beneath the U-tube. By raising the other reservoir, mercury is driven over, and the wetting liquid rises in the vertical tubes until the plug of powder is reached. The powder is held towards the top of one limb, by means of a plug of gauze or fibrous material of surface area less than that of the substance under study. When the powder is thoroughly wetted, the liquid is allowed to flow slowly back into the reservoir, control being effected by the tap.

The surface of the liquid is supported in one limb by the powder and falls in the other to a critical position at which the upper meniscus becomes detached from the plug. The difference in levels of the menisci (h) at the critical point is found to be connected with the mean radius (r) of the particles by the expression:

$$r = \frac{3mT}{hgad_1d_2l},$$

where m represents the weight of the powder used, T the surface tension of the wetting liquid, d_1 and d_2 the densities of liquid and powder respectively, while a and l represent the area of the tube and the length of the column of powder.

The value of l is found by flooding the column with liquid and, when free of air bubbles, sucking back on to the supporting plug.

It will be apparent that the use of a non-polar liquid is advocated in order to avoid adsorption on the powder, with the consequent increase in effective surface tension.

The accuracy of the method has been tested on a powder known to consist of nearly spherical particles, by comparing the results obtained by microscopical count with those found using carbon tetrachloride as wetting liquid. The mean result in each case was $r = 0{\cdot}017$ mm., the mean error of an observation of r by the method described above being 0·0008 mm.

It was found desirable to keep the length of the plug as short as possible, to ensure that air could readily pass through the powder when the meniscus became detached. This factor would no doubt set a lower limit to the size of particle measurable by the method, although the surface tension and density of the liquid can be adjusted to give the most favourable conditions.

The apparatus would seem to be readily applicable to other problems connected with particles; for example, the random packing of regular shaped bodies.

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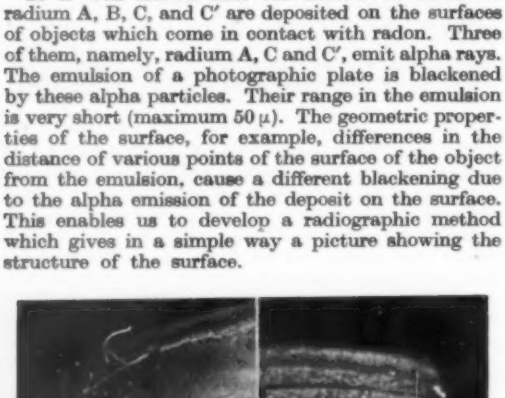
Surface Radiography with Alpha Rays

IT is well known that the short-lived atoms of radium A, B, C, and C′ are deposited on the surfaces of objects which come in contact with radon. Three of them, namely, radium A, C and C′, emit alpha rays. The emulsion of a photographic plate is blackened by these alpha particles. Their range in the emulsion is very short (maximum 50 μ). The geometric properties of the surface, for example, differences in the distance of various points of the surface of the object from the emulsion, cause a different blackening due to the alpha emission of the deposit on the surface. This enables us to develop a radiographic method which gives in a simple way a picture showing the structure of the surface.



A wing of a butterfly (*Vanessa io*) was exposed for two hours in a vessel (volume 70 c.c.) containing 1 mc. of radon. Afterwards the wing was put for 8 min. on the emulsion of a photographic plate ('Foma Repro'), and the plate then developed. Fig. 1 shows a positive copy of the original radiograph (× 3). With a microscope of low power the squamous structure of the wing can be seen in the picture. By the same method radiographs of polished surfaces of different kinds of wood were obtained; these show the fibrous structure of the wood (Fig. 2) (× 3). Wood moistened before the exposure in radon gave better results.

Controls without exposure in radon gave no pictures.

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A Suggested New Force Field for Molecular Vibrations

THE molecular force field which has been most successful in accounting for molecular vibration frequencies is the 'simple valency force field'. In many cases, however, this simple field has had to be modified considerably by introducing cross-terms. Most frequently these have been introduced empirically with the sole object of obtaining a good reproduction of the observed frequencies. This procedure is unsatisfactory, because it is often impossible to be sure of selecting the correct cross-terms from those that are possible. There have been a few more valuable attempts to modify the simple valency force field, and account for the cross-terms, which have been based on a more careful consideration of the forces, other than simple valency forces, that may exist in the molecule[1]. However, recently we have found that a new force field leads to more satisfactory results. We call this the 'orbital valency force field', and it differs from the older view in its treatment of angular distortions[2]; whereas the simple valency force field considers the bending angle by angle, the orbital valency force field treats it bond by bond.

In modern valency theory, directed chemical bonds are associated with directed atomic orbitals. Take boron tribromide as an example. The three bonding orbitals of the boron atom are of the sp^2 type and are arranged symmetrically in a plane[3]. Therefore, in the equilibrium configuration, the bromine atoms are arranged symmetrically around the boron atom. When a bromine atom is displaced at right angles to the B—Br bond, the overlap of its bond-forming orbital with that of the boron atom will decrease and there will be a force tending to restore it to its original position. For the motion to be simple harmonic the restoring force must be proportional to the displacement. Because the orbitals are symmetrical about their axes, the force constant will be independent of the direction of the displacement. That is, for boron tribromide, the same orbital valency force field bending constant may be used for the in-plane and out-of-plane bending. It is this that enables us to test the new field. For boron tribromide we use a potential energy function involving three constants: k_1 is the ordinary valency force field stretching constant; k_β the orbital valency force field bending constant; and $2A$ the second differential of the potential energy function (V') for the BrBr repulsion. $\frac{1}{R}\cdot\frac{dV'}{dR}$ (where R is the BrBr distance) also enters our formulæ, but this is put equal to $\frac{1}{3}$ of d^2V'/dR^2, which is the value it would have if $V' = a/R^{12}$, that is, if the repulsion between the bromine atoms is of a van der Waals' type[4]. $\frac{1}{R}\cdot\frac{dV'}{dR}$ is much smaller than k_1, k_β and A, so that its exact value is not of great importance. With $k_1 = 2{\cdot}385 \times 10^5$ and $k_\beta/r^2 = 0{\cdot}188 \times 10^5$ dynes per cm. the calculated frequencies are those given below:

Frequencies (cm.$^{-1}$)	$\nu_1(A_1')$	$\nu_3(E')$	$\nu_3(E')$	$\nu_4(A_1'')$
Obs. freq.[5]	279	806	151	372
Calc. freq.	279	815	151	372

The frequency of the in-plane bending vibration is ν_3 and of the out-of-plane bending ν_4. It will be seen that the average percentage error for all the frequencies is only $\frac{1}{4}$. Also the orbital valency force field accounts for the relative magnitudes of

the two bending vibration frequencies. The average percentage error between calculated and observed frequencies for other AB_3 planar molecules and ions is: BF_3: 0·1; BCl_3: 1·45; $CO_3^{=}$: 0·2; NO_3^{-}: 3·4; SO_3: 0·55. There seems no doubt, therefore, that the orbital valency force field provides a much more satisfactory force field than the simple valency force field which requires two unrelated bending constants for planar AB_3 molecules. We have also found that the orbital valency force field is better than the simple valency force field (both being combined with repulsion between the non-bonded atoms) for 'eight-tetrahalides' like CCl_4 and 'four-ions' like $SO_4^{=}$[6]. We are proceeding to apply the orbital valency force field to other molecules.

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Band Spectrum of Aluminium Bromide

The $^1\Pi - {}^1\Sigma$ system of AlBr near λ 2790 has been photographed in emission with high dispersion (0·6 A./mm.). Measurements of the Q heads have verified Howell's analysis[1]. Howell was, however, not able to make any definite observations on the isotope effect of the Q heads. Some of his Q heads, therefore, refer to the molecule $AlBr^{79}$, others to the molecule $AlBr^{81}$. On account of this, a new Q head formula has been calculated. Thus the band-origins of the molecule $AlBr^{79}$ can be represented by the formula:

$$\nu = 35879{\cdot}5 + 297{\cdot}2\,(v' + \tfrac{1}{2}) - 6{\cdot}40\,(v' + \tfrac{1}{2})^2 - 0{\cdot}527\,(v' + \tfrac{1}{2})^3 - 378{\cdot}0\,(v'' + \tfrac{1}{2}) + 1{\cdot}28\,(v'' + \tfrac{1}{2})^2.$$

The rotational structure of the 0,1 , 1,0 , 1,1 , 1,2 , 1,3 , 2,1 , 2,2 , 2,3 and 2,4 bands has been analysed. On account of the close structure, the bands were not resolved up to the heads. The analysis gives the following values for the band-constants:

$$B'_v = 0{\cdot}1555 - 0{\cdot}00216\,(v' + \tfrac{1}{2}) - 0{\cdot}000175\,(v' + \tfrac{1}{2})^2 \text{ cm.}^{-1}$$

$$B''_v = 0{\cdot}1591 - 8{\cdot}53 \times 10^{-4}\,(v'' + \tfrac{1}{2}) + 1{\cdot}4 \times 10^{-6}\,(v'' + \tfrac{1}{2})^2 \text{ cm.}^{-1}$$

$$D'_v = -[1{\cdot}8 + 0{\cdot}14\,(v' + \tfrac{1}{2}) + 0{\cdot}13\,(v' + \tfrac{1}{2})^2] \times 10^{-7} \text{ cm.}^{-1}$$

$$D''_v = -\,1{\cdot}09 \times 10^{-7} \text{ cm.}^{-1}$$

$$r'_e = 2{\cdot}322 \times 10^{-8} \text{ cm.}; \quad r''_e = 2{\cdot}296 \times 10^{-8} \text{ cm.}$$

The observed rotational isotope separations agree well with those calculated, but the approximate formula $\Delta\nu_v = (1 - \rho^2)\nu_v$ cannot be used.

The calculated values of the separations of R and Q heads agree well with those observed.

The frequency ω_e has been calculated from Guggenheimer's formula[2]. This gives in the case of AlBr, $\omega_e = 370{\cdot}3$, in rather good agreement with the observed value $\omega_e = 378{\cdot}0$.

A more detailed account of the analysis will be published in the *Ark. f. Mat. Astr. o. Fys.*

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Comparison of Metallographic and X-Ray Measurements of Retained Austenite

The martensite reaction in steels has been studied by microscopic examination of polished and etched samples after the samples have been tempered for short periods of time. One etching reagent which has been used is a solution of 6 per cent nitric acid in alcohol, which is called 6 per cent nital. This etchant stains the martensite grey or black and leaves the austenite white.

In quantitative studies of the amount of austenite which was retained after quenching to room temperature, this etchant appeared to obscure some of the austenite when the specimens were quenched from austenitizing temperatures below 1750° F. (954° C.). In steels exhibiting temper brittleness, Cohen, Hurlich and Johnson have found that the addition of a wetting reagent called 'Zephiran Chloride' to a modified picric acid etch reveals a precipitate not shown by other etching reagents[1]. ('Zephiran Chloride' is a trade-mark of Winthrop Chemical Company, Inc., indicating its brand of a mixture of high molecular alkyl-dimethyl-benzyl-ammonium chlorides, the descriptive name of which is benzyl-trialkonium chloride, marketed as an aqueous solution containing 12·8 per cent 'Zephiran Chloride'.) Therefore, 1 per cent 'Zephiran Chloride' was added to nital in an attempt to increase the sensitivity of the nital. Although 6 per cent nital is a better etchant than 4 per cent nital for steels containing small amounts of austenite, it is necessary to reduce the amount of nitric acid in the etch containing 'Zephiran Chloride' to 4 per cent because the 'Zephiran Chloride' increased the speed of etching.

Comparison of metallographic and X-ray measurements of amount of retained austenite at room temperature (68° F., 20° C.)

Austenitizing temperature	Metallographic measurements: Standard etch 6% nital	Metallographic measurements: Improved etch (4% nital and 1% 'Zephiran Chloride')	X-ray measurements
1450° F. (788° C.)	0	2·0 ± 1·0%	3·1 ± 0·2%
1550° F. (843° C.)	0	6·0 ± 1·0%	7·0 ± 0·4%
1650° F. (899° C.)	3·0 ± 3	14·0 ± 1·0%	14·0 ± 0·8%
1750° F. (954° C.)	17·0 ± 1	20·0 ± 1·0%	20·0 ± 1·0%

Critical measurements were made on a 1·1 per cent carbon, 1·4 per cent chromium steel, quenched into oil at 68° F. (20° C.) from a series of austenitizing temperatures listed in the accompanying table. X-ray measurements utilizing a new technique were made on these steels by Averbach[2]. Then the specimens were tempered for 10 sec. at 630° F., and were polished and etched. Quantitative measurements were made metallographically of the amount of retained austenite using a Hurlbut counter, described by Howard and Cohen[3]. The metallographic measurements with the improved etch were practically identical with the X-ray measurements, although the reproducibility of the X-ray results was better than that of the metallographic results, and the X-ray measurements revealed slightly more austenite than

the metallographic measurements in steels containing 7 per cent or less retained austenite. It is considered that nital is improved by the addition of 'Zephiran Chloride'. However, the reason for the improvement has not been established yet.

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Oct. 27.

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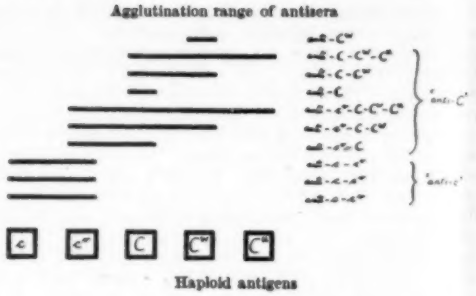
Rh Genes Allelomorphic to *C*

THE third allelomorph, C^w, at the *C-c* locus of the *Rh* chromosome was not recognized until a pure anti-C^w serum was found[1]; but its existence could have been demonstrated by testing several hundred samples of blood with a range of anti-*C* sera, for some of these sera are of the specificity anti-*C* and some, the majority, anti-$C + C^w$. It is not yet clear why the latter type of antibody may result from stimulation by the antigen *C*.



separated. When such a serum is absorbed by either c^ec cells or *Cc* cells, all agglutinin is removed. Similarly absorption of anti-$C + C^w$ sera by C^wc or by *Cc* cells results in the removal of both components. It is probable that in such natural mixtures the antibodies may be on the same molecule. If an artificial mixture is made by adding pure anti-C^w to pure anti-*C* serum, the separation of the antibodies by absorption with C^wc or *Cc* cells is specific.

It will be seen from the diagram that it is possible to represent the interactions of the allelomorphic antigens with the antisera in such a way that the

	anti	-*D*	-*E*	-*e*	-C^w	-*c*	'anti-*C*' -*C*	-*C*	-CC^w	-CC^w	-CC^w	-CC^w	Genotype
	Mother	+	+	+	−	+	−	−	−	−	−	−	*cDE/cde*
	Father	+	+	+	−	+	−	−	+	−	−	+	c^eDE/*cde*
c^e donor	1st son	+	+	+	−	+	−	+	+	−	−	+	c^eDE/*cde*
	2nd son	−	−	+	−	+	−	−	−	−	−	−	*cde/cde*
C^w donor		+	−	+	−	+	−	−	−	−	+	+	C^wDe/*cde*

In a search for further allelomorphs at this locus, 284 blood samples were tested with three anti-*C* sera, as well as with anti-*D*, -*E*, -*e*, -*c* and -C^w. Two bloods gave discrepant reactions with the anti-*C* sera; they were therefore more fully investigated and provided evidence of the existence of two more allelomorphs at this locus, which we propose to call c^e and C^u.

The agglutination reactions of the blood of the c^e donor and of his family are shown in the table. The table also shows the reactions of the C^u blood; the family of this donor was not available, and therefore the evidence for the existence of the fifth allelomorph, C^u, is somewhat incomplete.

The reactions given by the blood of the c^e donor and of his father were identical. The fortunate fact that the younger brother of the donor was *cde/cde* demonstrated clearly the exact genotype of each member of the family. The allelomorph c^e was segregating with *D* and *E* genes, and it was the partnership of these three genes on one chromosome that suggested that, in spite of the agglutination of the c^ec bloods by three out of six anti-*C* sera, the use of a small *c* was the more appropriate notation; for *cDE* is a common chromosome in England and *CDE* an extremely rare one. Strong support for this choice of notation was provided in the finding that the blood of both father and son gave a double-dose effect with the three anti-*c* sera available.

The anti-c^e component in the three anti-$C + c^e$ sera must have arisen in response to stimulation by the antigen *C*; the gene c^e is much too rare to have played a part in the three immunizations. The two components of an anti-$C + c^e$ serum have not been

positive reactions of the latter show as uninterrupted lines. We do not yet know whether this is a chance occurrence; if it is of significance, it seems to impose a definite linear order, in one dimension, on the allelomorphs. At least it is clear that the allelomorph c^e bridges the gap between *C* and *c*.

A more detailed account of this work will be published elsewhere.

We wish to thank Dr. J. Loutit and the members of his staff at the National Blood Transfusion Service, Sutton, for supplying us with the 284 blood samples.

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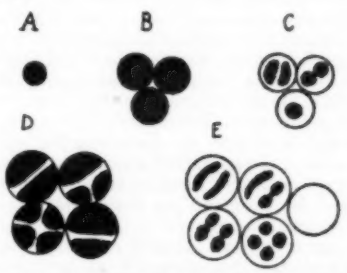
Cytology of Staphylococci Before and After Treatment with Penicillin

IN a previous communication[1], we showed that, by means of enzymes, it is possible to localize both the nucleic acids of bacteria: (1) ribonucleic acid in the cytoplasm, (2) desoxyribonucleic acid in the nucleus. Thus, we have found a method, which seems to be general, of demonstrating the nuclei of bacteria. This method has enabled us to observe the nuclei, already known to exist, of the bacteria of the enteric and the anthracis-subtilis group and to dis-

cover the nuclei of bacillus diphtheria, gonococci and staphylococci. We have continued our investigations which enabled us to demonstrate the nuclei of meningococci, streptococci and pneumococci. In our first group, the staphylococcus was most difficult to investigate, and we were able to show its nucleus only by treatment with an alkali (lithium carbonate) previous to the action of ribonuclease; but it was not very suitable because only isolated nuclei remained. We have overcome this difficulty by using higher concentrations of ribonuclease. It appears now that the method with ribonuclease, without previous alkaline treatment, has a quite general significance; but for each micro-organism it is necessary to study optimal conditions of ribonuclease concentration and duration of enzyme contact required to eliminate the whole content of cytoplasmic ribonucleic acid, while avoiding the non-specific lixiviation effect on the desoxyribonucleic acid of the nuclei due to long exposure to hot solutions.

As part of a general programme of research, we have investigated cytological variations of a staphylococcus strain (pyogenic *Staphylococcus aureus* isolated from a human boil), the bacteria having been cultivated either (1) on ordinary agar broth medium, or (2) on agar broth medium containing a sublethal concentration of penicillin (75 units per litre of medium for this bacterium) which delays growth without stopping it.



A. NORMAL STAPHYLOCOCCUS. GENERAL BASOPHILY. *B*. NORMAL STAPHYLOCOCCUS. NORMAL SWELLING DURING THE LAG PHASE. *C*. THE SAME, AFTER RIBONUCLEASE TREATMENT: NUCLEI. *D*. STAPHYLOCOCCUS TREATED WITH PENICILLIN. DEMONSTRATION OF THE BASOPHILIC MASSES. *E*. STAPHYLOCOCCUS TREATED WITH PENICILLIN, AFTER RIBONUCLEASE TREATMENT: NUCLEI. (ON THE RIGHT, EMPTY SHELL; CYTOLIZED CELL?) (DRAWN FROM PHOTOMICROGRAPHS)

Staphylococci cultivated on agar broth medium without penicillin. During the lag phase, the bacteria swell without multiplying, and after two or three hours they are twice as large as before. With the usual stains, they are entirely basophilic (Fig. *B*); but ribonuclease treatment demonstrates a nuclear apparatus (Fig. *C*). Then, there is in each coccus either a central or paracentral round nucleus, or, generally, two round or kidney-shaped nuclei showing divisions; rarely, three or four nuclei can be seen in the bacteria. After five or six hours, the lag phase comes to an end and the cocci multiply vigorously and regain their initial size. They have generally two or one nuclei.

Staphylococci on agar broth medium with penicillin. During the very first hours, the cocci keep their normal size, then they swell very much, so that their diameter is three or four times the initial diameter. Hypertrophic cocci are no longer entirely basophilic, and after treatment with the usual stains, two, three or four chromophilic masses, separated by clear areas, may be observed (Fig. *D*). Ribonuclease treatment discloses two to four or sometimes five round or kidney-shaped nuclei showing numerous divisions (Fig. *E*). It seems that one or two nuclei form the centre of each basophilic mass which has already been mentioned. Later, most of the cocci gradually regain their usual size, and multiplication begins. But basophilic masses are found in bacteria as long as the micro-organism lives on a medium containing penicillin. When bacteria which have grown on agar medium with penicillin are transplanted on agar medium without penicillin (or agar medium with penicillin plus penicillinase) they regain their initial cytology, are entirely basophilic and have generally no more than two or one nuclei, according to the age of cultivation.

Summarizing: (1) penicillin produces, with staphylococci, during the lag phase, an exaggerated swelling; (2) it changes the bacterial cytology and elicits differentiation of chromophilic masses separated by clear areas, an appearance which is not observed in normal bacteria even when they are old; (3) it interferes with multiplication by inhibiting cytoplasmic rather than nucleal divisions.

We are endeavouring to find out, by chemical means, the variations of desoxyribonucleic and ribonucleic acid content in bacteria treated with penicillin. The results of these experiments will be reported later; but we assume that the basophilic masses which can be observed under the influence of penicillin owe the most important part of this chromatophily to ribonucleic acid. After staining bacteria with neutral red, Pratt and Dufrenoy[2] have recently published drawings of staphylococci treated with penicillin which are similar to ours before ribonuclease treatment. They think that basophilic masses should be considered as vacuoles fixing the dye. So far as we are concerned, we think that these masses are perinuclear cytoplasmic areas in which ribonucleic acid has been stored, as a result of bacterial 'ill-health' due to the antibiotic.

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Nov. 15.

[1] Tulasne, R., and Vendrely, R., *Nature*, **160**, 225 (1947).
[2] Pratt, R., and Dufrenoy, J., *J. Bact.*, **54**, 127 (1947).

Subtilin C: an Antibiotic Concentrate from *Bacillus subtilis*

A CONSIDERABLE literature[1], dating back to 1897, has established the activity of *Bacillus subtilis* strains against a variety of bacteria as well as viruses. A limited amount of work has been done on the isolation of the active constituents of *B. subtilis* cultures, and although several concentrates with distinct properties have been described, no pure active compounds have yet been defined.

In recent publications[2] by members of the Northern and Western Regional Research Laboratories, United States Department of Agriculture and the University of California, extensive investigations on the production of the active antibiotic concentrate subtilin from two strains of *B. subtilis* (*A.T.C.C.* 6633, *N.R.R.L.* B 543; and *A.T.C.C.* 7080, *N.R.R.L.* 537) have been described, together with some of its properties. As part of this work has been duplicated here during the past eighteen months, the results of

investigations to date are now recorded. A more detailed account will be given elsewhere.

Of the twenty strains of *B. subtilis* examined, the strain *A.T.C.C.* 6633 displayed greatest antibacterial activity, the metabolism solutions being adjusted to *p*H 2·5 and autoclaved at 114° C. for ten minutes. The active concentrate subtilin had been isolated from surface cultures of this strain by Jansen and Hirschmann[1]. We used quick-freeze dried cells grown in submerged culture with aerating agitation on a medium of corn-steep liquor and sucrose. It was found, after several trials with different solvents, dilute acids, and inorganic salts, that the active principle was most advantageously separated when the cells were disintegrated in alcoholic suspension with glass beads or autoclaved with 80 per cent aqueous alcohol. By the use of the latter procedure, followed by dilution of the alcoholic extract with adjustment of the *p*H to 2·3, an active concentrate, which we will term subtilin *C*, was obtained as an amorphous powder.

Subtilin *C* in high concentration (1/2,000) was inactive against the Gram-negative bacteria tested, but Gram-positive organisms were generally susceptible to high dilutions; acid-fast bacteria showed a range of sensitivity. The substance had no lytic effect on a variety of organisms. It diffused only with great difficulty.

Antibacterial activity was determined by serial dilution of solutions or fine suspensions of subtilin *C* which had been adjusted to *p*H 2·5 and autoclaved at 114° C. for 10 minutes.

	Highest dilution of subtilin *C* giving 50% inhibition of growth after 24 hr. at 37 C. in glucose broth
Sarcina lutea	1/10,000,000
Staphylococcus aureus (6 strains)	1/80,000–1/8,000,000
Corynebacterium xerosis	1/5,000,000
Lactobacillus helveticus	1/2,400,000
Micrococcus conglomeratus	1/600,000
Mycobacterium from butter	1/300,000
Mycobacterium phlei	1/60,000

Complete inhibition of growth was given by two to four times the amounts of subtilin *C* required for 50 per cent inhibition.

Subtilin *C* is stable under certain conditions. A preparation stored for five months at room temperature in a desiccator in the dark showed no loss of activity. In solution in glucose broth, *p*-aminobenzoic acid (200 μgm./ml.), nicotinic acid, pantothenic acid and riboflavin (5 μgm./ml.), aneurin and pyridoxin (2 μgm./ml.), biotin (0·1 μgm./ml.), folic acid (0·01 μgm./ml.), 2 per cent casein hydrolysate, and asparagine and tryptophane (0·1 per cent), exerted no antagonistic effect in the concentrations given. The same was true of solutions of sodium chloride (2 per cent), glucose (2 per cent) and cysteine (0·04 per cent).

Under some conditions, the antibacterial properties of subtilin *C* were impaired. Exposure to sunlight for two days reduced the activity to 10 per cent of darkened controls at various *p*H values. With serum the results were not clearly defined. Using *Staph. aureus* as test organism, no significant loss in activity was observed over short periods (24 hr.), but contact for three days reduced the activity to 25 per cent of the original. Seitz filtration of a solution of the antibiotic resulted in loss of activity. Studies on the stability of solutions at various *p*H values showed that subtilin *C* was most stable at *p*H 2·5. It is rapidly destroyed in alkaline solution.

The properties of subtilin *C* would support the view that the active principle is a polypeptide. Hydrolysis by trypsin and pepsin resulted in loss of activity. It gave a strong ninhydrin reaction for α-amino-acids and positive tests with Ehrlich's reagent for indole derivatives and the Folin–Denis reagent for phenols. No coloration developed on treatment of an alcoholic solution with ferric chloride; this differs from the results obtained by the American workers.

I am indebted to Dr. F. Bergel and Prof. A. R. Todd for helpful suggestions and a continued interest in this work; also the assistance of Dr. Klein, Dr. Moss and Miss Ward in the microbiological work is gratefully acknowledged.

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Nov. 4.

[1] Jansen, E. T., and Hirschmann, D. J., *Arch. Biochem.*, 4, (3), 297 (1944).

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Serological Position of *Streptococcus bovis*

Streptococcus bovis, a conspicuous streptococcus of cow dung and also occurring in human fæces, has proved difficult to classify. Biochemically it is a well-defined species (Orla Jensen), and although it has some of the characteristics of Lancefield's Group *D* streptococci, its serological identity has long been obscure because of its failure to yield a group serum. While many strains of *Str. bovis* reacted with Group *D* sera, a not inconsiderable proportion gave negative or equivocal results[1,2,3], and until group sera for *Str. bovis* could be prepared its serological placing was necessarily left in abeyance.

Using an improved method of extraction, it has now been shown that virtually all strains are precipitated with a Group *D* serum. Moreover, by further improvement in the method of preparation of suspensions for inoculation, it has been possible to produce group specific sera from *Str. bovis* itself. Reciprocal absorptions with these sera and with sera prepared from other authentic Group *D* strains confirm that *Str. bovis* now takes its place with the enterococci as a member of Group *D*.

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Nov. 12.

[1] Mattick, A. T. R., and Shattock, P. M. F., *Mon. Bull. Emerg. Pub. Hlth. Lab. Serv.*, 2, 73 (1943).

[2] Shattock, P. M. F., and Mattick, A. T. R., *J. Hyg., Camb.*, 42, 173 (1943).

[3] Sherman, J. M., *J. Bact.*, 35, 81 (1938).

Intravenous Methylene Blue: a New Method for Studying the Nervous System

In 1886, Ehrlich[1] obtained striking results by the use of methylene blue as a stain for the nervous system. Of the many methods since developed for utilizing the staining properties of methylene blue perhaps the simplest and most reliable is the local injection technique of Weddell *et al.*[2]. The two main disadvantages of this method are the inevitable distortion of the tissue by the direct injection of the

staining fluid and the limitation of the size of the region stained. Both objections may be overcome by continuously perfusing methylene blue into the veins of a living animal, conditions being so arranged that the animal survives for an extended period. The details of the technique are being published in full elsewhere[3], but the results obtained are so consistent that it was felt worth while to point out some of the possibilities of the method.

There appears to be no serious restriction on the number or type of tissues which can be studied in this manner, and the application of the method has already made possible detailed investigations on the pattern of innervation in striated muscle, blood-vessels (Millen[4]), and the cornea.

Fine morphological details may also be demonstrated, both in the peripheral and central nervous system. Thus, complicated end-organs such as muscle spindles stain with remarkable clarity, and a most striking feature is the demonstration of *boutons terminaux* in the central nervous system. *Boutons* have been observed in regions, such as the cerebral cortex, where they have previously been stained only with great difficulty or not at all.

There are many physiological problems to which this type of study might with advantage be applied. To take but one example, it should be possible, in cases of experimental poliomyelitis, to obtain a correlation between the condition of the affected muscles and that of the central nervous system in the same animal. For these reasons it appears that the method possesses considerable potentialities, in that it renders possible integrative studies of the functional anatomy of the nervous system.

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Nov. 18.

[1] Ehrlich, P., *Biol. Zentralblatt*, **6**, 214 (1886).
[2] Weddell, G., Harpman, J. A., Lambley, D. G., and Young, L., *J. Anat.*, **74**, 255 (1940).
[3] Feindel, W. H., Sinclair, D. C., and Weddell, G., *Brain* (in the press).
[4] Millen, J. W., *J. Anat.* (in the press).

Influence of Low Bicarbonate Concentrations on the Growth of a Green Alga

The role of bicarbonate ions as a source of carbon for aquatic plants has been a subject of discussion for a long time. Steemann Nielsen[1] has recently given a short history of this question and published experiments showing that *Myriophyllum* has a greater ability than *Fontinalis* to use carbon from bicarbonate.

My own experiments have been made with a planktonic Green Alga, *Scenedesmus quadricauda* (Turp.) Bréb., and show that its behaviour is rather different from that of higher plants. The culture conditions of the inoculating material were the same as previously described[2], except that half the sodium carbonate had been exchanged for an equivalent amount of potassium carbonate.

In the experiments the Algæ were cultured in Jena glass tubes with 10 ml. of solution in each. The cultures were aerated with air (0·03 per cent carbon dioxide), or a mixture of 5 per cent carbon dioxide and 95 per cent air. The nutrient solution contained the same constituents as the solution for growing the inoculating material except that the carbonates were exchanged for equivalent amounts of disodium and dipotassium hydrogen phosphate, thus giving the solution a buffer of 1/44 *M* phosphate. The *p*H was regulated by adding various amounts of hydrochloric acid. After inoculation, the gas mixture that was used was blown through the cultures in the dark until the pressure of carbon dioxide in the solution was the same as in the gas mixture, that is, until the *p*H had a constant value. Usually four hours was enough. The cultures were then illuminated for ten hours. Four parallels were run, one of which was used up for *p*H determination at the beginning of the growth period, so that the growth determinations were made on three tubes the mean values of which are given in the accompanying figures. Growth was measured photometrically.

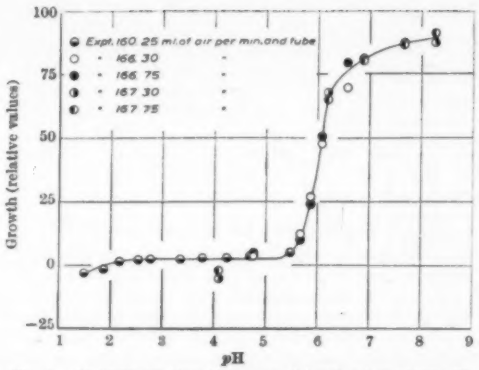

Fig. 1. Growth of *Scenedesmus quadricauda* at various *p*H-values in cultures aerated with air

When air is blown through the cultures, we get the curve of Fig. 1. Three experiments have been combined to form it because it was technically impossible to get all the points from one experiment. In two of the experiments two different rates of aeration have been used, and they show no difference. Another experiment has shown that carbon dioxide is taken up so rapidly from the air that, with the density of population used, the solution is practically in equilibrium with the air all the time. If a larger amount of inoculating material is used, this is no longer the case, and then the *p*H rises during illumination and falls to the original value in the dark if the aeration is continued.

The curve (Fig. 1) shows that growth is low between *p*H 2 and 5·5. Between *p*H 5·5 and 6·2 the curve rises very rapidly and continues to *p*H 8·2, which is the highest obtainable *p*H-value with this solution. In other experiments, not reported here, carbonate buffers have been used; and it is then possible to make growth determinations up to *p*H 9·8. The curve from this experiment shows an optimum at about *p*H 9 to which the 100 per cent in Fig. 1 refers.

The rapid rise in growth between *p*H 5·5 and 6·2 is not a direct effect of the acidity, for if 5 per cent carbon dioxide is blown through the cultures, growth is good even at *p*H 3–4.

I think the cause is to be found in the concentration of bicarbonate ions. In Fig. 2 we see the critical points of Fig. 1 placed in a graph where the abscissæ are the concentrations of bicarbonate ions, calculated from known constants. The growth is directly proportional to the concentration of bicarbonate between 1·5 and 9 μmol./l.

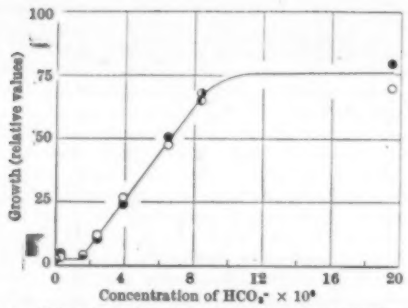

Fig. 2. Growth of *Scenedesmus quadricauda* at various concentrations of bicarbonate ions

The slight growth below 1·5 μmol./l. must be ascribed to the free carbon dioxide or carbonic acid, the concentration of which is 10 μmol./l. at all *p*H-values. A strange fact is that bicarbonate in concentrations below 1·5 μmol./l. was not assimilated. At bicarbonate concentrations greater than 9 μmol./l., growth is no longer limited by this substance but by other factors.

Steemann Nielsen (*loc. cit.*) has found that *Myriophyllum* and *Fontinalis* use carbon dioxide more rapidly than bicarbonate ions. In the case of *Scenedesmus*, we see that in a carbon dioxide concentration of 10 μmol./l., growth is very small; but in the same concentration of bicarbonate ion the growth amounts to 75 per cent of the optimal growth. Thus we see that various plants behave very differently with regard to the carbon source: *Fontinalis* assimilates about ten times better in carbon dioxide than in bicarbonate, and *Myriophyllum* two to five times better; but *Scenedesmus* grows twenty-five times better in bicarbonate than in carbon dioxide.

From Steemann Nielsen's curves one can see that the ability to use carbon dioxide is about the same for *Myriophyllum* and *Fontinalis*. The assimilation at 10 μmol./l. of carbon dioxide is very slow; and this is also the case with *Scenedesmus*. The differences are to be found instead in the ability to use bicarbonate. *Fontinalis* has a very slow assimilation in 10 mmol. of bicarbonate per litre, the assimilation of *Myriophyllum* amounts to 50 per cent of the optimal at 1 mmol./l., and *Scenedesmus* has 75 per cent of its optimal growth at 0·01 mmol./l.

It is very probable that these facts affect the distribution of the plants in lakes.

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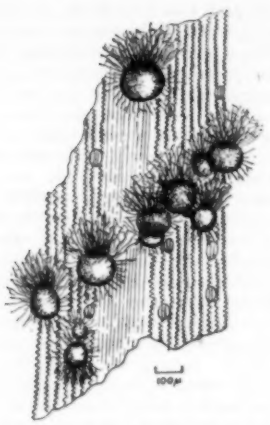
[1] Steemann Nielsen, E., *Nature*, **158**, 594 (1946).
[2] Österlind, S., *Nature*, **159**, 199 (1947).

A *Chætomium*-like Thermophile Fungus

Among the various organisms which have been isolated at this Station from fermenting straw composts, one, *M.R.A.* No. 112, is of special interest. It is a thermophile Ascomycete producing perithecia which in many respects resemble those of the genus *Chætomium*.

Between the temperatures 40° C. and 50° C., on slopes of 3 per cent malt extract agar, *p*H 5·5, in a saturated atmosphere, vegetative growth is most luxuriant and perithecia are most abundant and most fertile. At 45° C. a small amount of mycelium deposited about the centre of a slope 7 cm. × 1·5 cm.



Perithecia of thermophile fungus, *M.R.A.* No. 112, on piece of straw, approx. × 40 (semi-diagrammatic)

spreads over the whole surface, often within the first twenty-four hours; procarpal structures and perithecial initials are well developed within thirty to sixty hours, and many fully formed perithecia containing ascogenous structures, asci or even liberated spores are to be found within ninety-six hours.

Below 37° C. and above 55° C., growth on 3 per cent malt extract agar slows down markedly and ceases between 25° and 26° C. and between 61° and 62° C.

This remarkable fungus, which is probably a new species, surely holds the high-temperature record for vegetative growth and production of perithecia among Ascomycetes. Its taxonomic position is still under consideration; but as soon as this has been decided, further data, including descriptive details, will be published.

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Treatment of Apple Canker Lesions with Plant-growth Substances

Given that the formation and spread of a canker depends on the balance between the growth of the pathogen and the regeneration of the host, a substance which stimulates wound healing may prove as effective in combating the disease as one which aims at suppressing the pathogen. A number of the chemicals known as plant-growth substances stimulate callus formation, and it is possible that some of these may also suppress the development of the pathogen.

The effect of a number of growth substances on *Nectria galligena* Bres., the cause of apple canker, has been examined. In the first method used, records were made of the growth of the fungus on 2 per cent malt agar (*p*H 4·8) to which had been added 100 p.p.m. of the substance. It was found that during the greater part of the growth the increase in diameter was constant, and it was therefore possible to calculate a coefficient of linear regression of diameter on time which gave a fair estimate of the average growth-rate. Secondly, the effect of these substances on the growth of the fungus in liquid culture was observed by comparing dry weights of colonies grown in nutrient solutions

containing varying concentrations of the substances in question. None of the substances used was strongly fungicidal and, although the more toxic produced a marked reduction in growth in relatively small concentrations, growth was not completely inhibited at very much higher concentrations. It was therefore found convenient to record as the toxic concentration the quantity required to reduce growth to less than 5 per cent of the controls. As the toxicity of these compounds is increased with increasing acidity, it is necessary to state the *p*H of the medium when quoting toxicity figures. The results of the tests described above are shown in the accompanying table, in which the second column relates to the tests on agar and the third column is derived from the results obtained in nutrient solution.

EFFECT OF PLANT-GROWTH SUBSTANCES ON THE GROWTH OF *N. galligena*

Substance	Growth-rate (mm. per day)	Toxic conc. in p.p.m. (*p*H 3·8)
2,4,6-Trichlorophenoxyacetic acid	1·22 (± 0·07)	40
1-Chloro-2-naphthoxyacetic acid*	1·07 (± 0·02)	40
α-Naphthaleneacetic acid	1·40 (± 0·05)	20
β-Indolylbutyric acid	2·37 (± 0·11)	60
β-Indolylacetic acid	2·59 (± 0·04)	100
β-Naphthoxyacetic acid	2·67 (± 0·16)	60
2,4-Dichlorophenoxyacetic acid	2·20 (± 0·09)	80
Control	3·01 (± 0·09)	

* Supplied by F. E. Smith, of Pal Chemicals, Ltd.

In preliminary field trials these substances were applied to established cankers at a strength of 1 per cent in lanoline; the cankers treated with β-indolylbutyric acid showed a marked improvement over the controls, but the others showed little difference.

These failures may possibly be due to the use of concentrations which were high enough to be toxic to the host.

I am grateful to Dr. L. C. Luckwill and to Mr. R. W. Marsh for their advice during the course of this work.

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A New Dry Test for Gold

During the course of a systematic investigation of the mechanism of the blue mantle test for tin[1], it has been recently observed in these Laboratories that gold shows a similar reaction, but the colour of the mantle is a brilliant green.

The following procedure is adopted. Add to the gold salt in a porcelain dish a quantity of concentrated hydrochloric acid. Add a speck of metallic zinc and immediately dip a test tube, full of water, in the solution over the point where the hydrogen is bubbling up. On holding the test tube in the hottest portion of a Bunsen flame, a brilliant green mantle forms around the bottom of the test tube. The test is sensitive to 0·1 mgm. of gold per c.c. of concentrated hydrochloric acid. The presence of tin, however, interferes, and the green mantle is replaced by the characteristic blue mantle of tin. Copper also interferes.

As mercury, lead, silver and even platinum ions do not interfere, gold can be easily detected in a tin-free ore or alloy by dissolving the nitric acid insoluble portion in *aqua regia* and then applying the above test.

The mechanism of the test is not known.

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Chemical Laboratories,
University of Allahabad.
Oct. 14.

[1] Meissner, H., *Z. Anal. Chem.*, **80**, 247 (1930). Schröer, E., and Balandin, A., *Z. Anorg. Chem.*, **189**, 258 (1930).

Demonstration of the Heart Beat

The explanation of Dr. C. A. Beevers' observations[1] (which I can confirm and to which I would add the further observation that the puffs of smoke correspond to cardiac systole) would seem to lie in the close resemblance of the human chest to the box used for the production of smoke rings to which he refers. Both have relatively rigid walls with a diaphragm and an orifice. In the case of the chest the contraction of the heart muscle during systole, acting from the relatively fixed great vessels of the head and arms, pulls its diaphragmatic attachment upwards, thus reducing the volume of the thorax. Air, being the most easily displaced thoracic content, is expelled in small jets corresponding to each cardiac systole and produces the effect noted by Beevers.

That it is not brought about by arterial pulsation in the mouth is certain because, during the process of blowing smoke from the mouth, the latter is in free communication with the lower air passages, and the comparatively small effect of local vascular changes would be lost in the very much greater volume of air (approximately 3 litres) present in the lungs and respiratory passages.

A possible additional cause is the throwing during each systole of upwards of 60 ml. of blood into the pulmonary circulation with displacement of air from the alveoli as the pulmonary capillaries dilate. This, however, is likely to be a much more gradual process and to be delayed for a considerable interval after systole.

Changes in the volume of the heart itself during the cardiac cycle might be thought to play a part; but consideration will show that any expulsion of air would be diastolic in time and also more gradual than a similar effect accompanying systole, being dependent on the flow of blood into the thorax via the superior and inferior venæ cavæ rather than its sudden expulsion from the heart.

It is doubtful if the accurate measurement of these pressure changes suggested by Dr. Beevers would provide any more valuable evidence of the condition of blood vessels than can at present be obtained by direct observations on an artery, as with various forms of sphygmograph, or on the volume changes in a limb with a plethysmograph.

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[1] Beevers, C. A., *Nature*, **161**, 65 (1948).

On looking further into the literature, I find that the 'cardio-pneumatic movement' has been described many times previously. For example, Haycroft and Edie (*J. Physiol.*, **12**, 426; 1891) quote C. Voight as having recorded the phenomenon in 1865. However, these workers seem to have used a glass tube inserted into the mouth with a drawn-out portion in which the movements of the smoke particles are observed.

C. A. Beevers

INTERNATIONAL MEETING ON ANIMAL PRODUCTION

By I. L. MASON

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A MEETING, sponsored by the Swiss Zootechnical Society, was held in Zurich during October 8–9, 1947, in order to renew professional and personal contacts severed by the War and to discuss the proposed formation of an International Society of Zootechny (or Animal Production). It was organised by Dr. W. Engeler, secretary of the Swiss society, and great credit is due to him and his colleagues for arranging the meeting at such short notice.

There were about 250 participants from twenty-six countries, and eighteen of these countries were represented by official Government delegates. Apparently the only delegate from outside Europe was Dr. Riddell, the United States agricultural attaché at The Hague, who was the official American representative. The only visitors from Great Britain were Mr. Alec Hobson (secretary of the Royal Agricultural Society of England and also representing the British Society of Animal Production), Mr. and Mrs. Gerald Strutt (Royal Agricultural Society of England), and Mr. and Mrs. I. L. Mason.

At the opening ceremony addresses of welcome were given by representatives of the Federal Department of Agriculture, the Swiss Zootechnical Society, the Swiss Breeders' Federation, and the Federal Technical College, where the meetings were held. All the speakers recalled with pleasure the International Conference on Animal Breeding held in Zurich in 1939, and hoped that the work interrupted by the War could now be continued.

At the first technical session, Dr. I. Moskovits, head of the animal husbandry section of the Temporary European Bureau of the Food and Agriculture Organisation, Rome, gave an exhaustive account of the international livestock situation, with particular reference to changes in livestock numbers, country by country, during the War, and Dr. A. Kiener presented a vivid picture of the Swiss livestock industry. It was very interesting to observe that the War had had much the same effects on livestock production policy in Switzerland as in Britain, namely, sharp reduction in pig and poultry stocks, owing to absence of imported feeding-stuffs, and emphasis on milk rather than on meat production.

On the second day of the meeting, official reports on the state of animal breeding in the following European countries were circulated: Austria, Belgium, Denmark, Finland, France and the Netherlands. In addition, Dr. Riddell and Prof. Csukás gave verbal accounts of animal breeding in the United States and Hungary respectively. Dr. H. Aersoe spoke on bull testing in Denmark; this information is already available in published form (*226. Beretning fra Forsøgslaboratoriet*, Copenhagen, 1947). In the discussion, Dr. Rijssenbeek (Netherlands) criticized the absence of daughter/dam comparisons and the restriction of the test to autumn calve s. Dr. Horn (Hungary) pointed out the difficulty of comparing one year with another in a Continental climate; his observations also showed that some bulls might raise the annual yield, but depress the life-time production of daughters compared with dams. Dr. Rijssenbeek read a paper entitled "Horse-Breeding in the Netherlands"; it included an account of an apparatus for measuring the pulling power of horses, designed by Prof. Visser.

The rest of the day was devoted to the proposed International Society of Animal Production. The discussion was based on the provisional statutes drawn up by the 1939 meeting. Those most desirous of forming the Society were Dr. Rijssenbeek, Dr. Engeler and Prof. Leroy (France). It was finally decided: (1) that an International Society of Animal Production should be formed on a Continental basis; the Continental sections could later link to form a world association; (2) that the society should be private and not governmental, and should be based on the zootechnical societies of each country; these societies include scientific workers, breeders, and administrators; (3) that a preparatory committee should be formed by representatives of the national zootechnical societies in Belgium, Denmark, France, Hungary, Netherlands, Switzerland and the United Kingdom; (4) that the secretariat should be at the Food and Agriculture Organisation Bureau in Rome, and Dr. Moskovits would be responsible for convening the committee; (5) that the committee should prepare a draft constitution and report at the next International Meeting on Animal Production, to be held in Paris in 1949. The preparatory committee would also prepare the agenda for the next conference. Dr. Moskovits suggested that the projected International Society might help to co-ordinate the research programmes in the smaller countries. At the moment, too many small experiment stations are attempting too much for their resources and achieving too little. Mr. Hobson described the formation and objects of the British Society of Animal Production, and promised its co-operation.

The meeting was conveniently arranged to coincide with the sixteenth Swiss National Livestock Show. This is a big event, lasting for nearly a month, horses, small stock and cattle being shown in succession. Judging was done before the public was admitted, and the prize animals were periodically paraded round the ring. In this parade, however, the emphasis was on the breed rather than the individual, and attention was directed to the characteristics, distribution and performance of each. In this way we were able to see the famous improved breeds of Swiss goats—the Saanen, Toggenburg, Appenzell, and polled Chamois—as well as the horned Chamois, Grisons, Verzasca, and Valais Blackneck, representing the mountain types. Most of the pigs in the country are Improved Landschwein or Large White. Sheep are of less importance; we saw the White Swiss Alpine, Brown-headed Mutton (Oxford) and the Black-brown Mountain breeds.

Cattle are by far the most important livestock in Switzerland. Two breeds divide the country between them—the Swiss Brown in the east and the Simmental in the west. They were excellently presented at the show, and in view of the single- versus dual-purpose controversy in Great Britain, it was extremely interesting to see such good examples of functional *triple*-purpose animals. In presenting them, the emphasis was placed on the importance of maintaining a balance between the production of milk, work and meat.

Further opportunity of studying these animals was provided by the expeditions organised in connexion with the meeting. We went to Einsiedeln in Canton Schwyz, the place of origin not only of the Swiss Brown cattle, but also of the Swiss Confederation itself. We saw three herds of Simmental cattle in the

Emmental and Simmental. Finally, we inspected Jura (or Freiberg) horses in the neighbourhood of Delémont, in the Bernese Juras. This is the only native Swiss breed ; it is a light-draft type, developed during the last fifty years. Wherever we went we were warmly welcomed and most hospitably entertained.

The arrangements for the conference were excellent. It is all the more unfortunate that the currency restrictions which prevail at every frontier prevented many people attending the conference and reduced to a minimum the stay of many others. Voluminous literature was available about the Swiss breeds of livestock. More important, these books and brochures were not merely propaganda, but gave factual accounts of characteristics and performance of animals and of methods of breeding and herd book registration.

INSULATING MATERIALS AND METHODS FOR USE AT LOW TEMPERATURES

THE Low Temperature Group of the Physical Society at a meeting on December 18, 1947, discussed insulating materials for use at low temperatures.

Sir Alfred Egerton, in the course of his presidential address to the Group, referred to the fact that the heat transfer by radiation in vacuum-jacketed vessels is greater than that predicted from theoretical calculations based on emissivities obtained from the electrical conductivities, and mentioned that a copper surface reduced with hydrogen at 300° C. is a better reflector for heat waves than a polished surface.

Sir Alfred then described thermal conductivity determinations carried out under his and Prof. Newitt's direction by Dr. C. S. Chow at the Imperial College. The apparatus consisted of an inner cylinder maintained at low temperature by liquid oxygen and an outer cylinder which served both as a heater and a water flow-calorimeter ; the material under test being packed between. Thermocouples were located at various positions to give the temperature distribution. Some of the data obtained are quoted below. They are mean thermal conductivities for a cold-face temperature of −181° C. and a mean temperature of about −84° C.

Material	Description	Bulk density (gm./c.c.)	Thermal conductivity (gm. cal. cm./cm.² sec. °C.)
Granulated cork, baked	49·5% 10–20 mesh 50·5% through 20 mesh	0·101	0·000066
Vermiculite	10–14 mesh	0·216	0·000112
	4–10 mesh	0·144	0·000082
Mixed ,,	7·9% 3–4 mesh 26·5% 4–10 ,, 65·6% 10–14 ,,	0·157	0·000101
Wadding	Crude cotton wool	0·042	0·000062
Slag wool		0·059	0·000076
,, ,,		0·130	0·000044
,, ,,		0·197	0·000062
Cotton waste	Tangled thread form	0·131	0·000092

In a contribution from the National Physical Laboratory, Dr. Ezer Griffiths and Mr. M. J. Hickman reviewed the physical properties of insulating materials which have to be taken into account in practice in addition to thermal conductivity. They are bulk density, specific heat, fire resistance, water absorption, water repellency, permeability to water vapour, mechanical strength and settlement under vibration. The procedures for measuring these properties were outlined. For measuring thermal conductivity over the range of temperature of interest in refrigeration work, the hot-plate method was adopted : the plate being fitted with a coplanar guard ring. For the measurement of thermal conductivity down to about −78° C., a box or cylinder method has been used, the box being made of the material under test. The cold-face temperature was maintained at a constant low temperature by the use of a block of solid carbon dioxide, and the rate of sublimation of the solid carbon dioxide afforded a measure of the heat flow into the box.

A few of the results obtained with the various forms of apparatus are summarized below :

Material	Bulk density (gm./c.c.)	Mean temperature (°C.)	Thermal conductivity (gm. cal. cm./cm.² sec. °C)
Expanded ebonite	0·086	−27	0·000067
Balsa wood ..	0·101	−27	0·000075
Baked slab cork ..	0·107	−27	0·000079
,, ,, ,, ..	0·160	−27	0·000082
Cellular polystyrene	0·08	0	0·00010
Cellular chlorinated rubber	0·11	0	0·000092
Corrugated cellulose acetate sheets superimposed		−2	0·00011
Kapok (ceiba fibre)	0·016	0	0·000072
Slag wool (water repellent)	0·176	−8	0·000085
Bonded glass fibre	0·048	0	0·000080
Cellular glass (fine pored)	0·18	−2	0·00013,
Cellular polyvinyl formal	0·06	10	0·000090
Cellular ebonite (synthetic rubber)	0·07	10	0·000080
Foamed glue	0·03	16	0·000085

Dr. A. M. Clark (British Oxygen Co.) stated that the energy required to compensate the leakage of a unit of heat into a system at liquid oxygen temperature is fifteen to twenty times as great as that required to compensate for the leakage of the same quantity of heat at −30° C. The efficiency of a vacuum at liquid air temperature is about fourteen times that of a 10-cm. layer of a material such as baked slab cork. The complexity of the arrangement of a large industrial low-temperature plant, however, renders vacuum insulation impracticable to any great extent. He stated that the largest vacuum-insulated tank yet made for the storage of liquid oxygen had a capacity of 57 tons and an evaporation loss of 0·16 per cent of its contents per 24 hours. The largest storage vessel insulated with rock wool had an evaporation loss on the same basis of 0·2 per cent.

Sir Alfred Egerton stated that a vacuum-jacketed vessel of 30 gallons capacity for the storage of liquid methane had a rate of loss of 1¼ gallons per 24 hours.

Dr. P. M. Schuftan (Gas Separation Branch, British Oxygen Co.) gave figures to show that the effect of improved insulation in oxygen plants was rather smaller than expected. For example, in an oxygen storage tank of 300,000 ft.³ capacity fitted with the usual magnesia insulation, about 3 per cent of the product is gasified by heat influx from outside. This amount of gas can, as a rule, be fully utilized for cylinder filling and only the latent heat of the oxygen is lost, adding about 2 per cent to power consumption and 1 per cent to total operating costs.

Prof. F. E. Simon discussed the process of heat conduction in solids, emphasizing the role of the mean free path of the heat waves. Reduction of the mean free path by disturbing the lattice, either physically (mechanical distortion, use of supercooled disordered phases) or chemically (alloying), gave a very low thermal conductivity at low temperatures.

In the subsequent general discussion, stress was laid on the possibilities of an insulator composed of powder or fibres with gas at low pressures in the interspaces.

EZER GRIFFITHS

SOME NEW ANISOTROPIC TIME EFFECTS IN RHEOLOGY

By S. M. FREEMAN and K. WEISSENBERG
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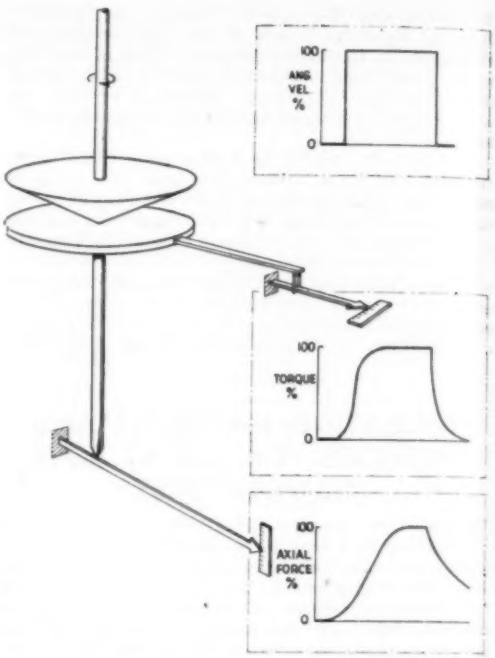
IN rheology we study the development in space and time of the *mechanical variables*, that is, of the stresses and strains which co-exist in a material in every differential cell, and at every instant. Our concern here will be the comparison between different directions in space, and we shall speak with respect to any quantity, or development, of *isotropic* symmetry to denote identity in the various directions, and of *anisotropic* symmetry to denote differences from one direction to another.

Let a material be observed as it passes under some mechanical action through a series of rheological states, and let all such states be divided into *sheared* and *shear-free* states according as we can, or can not, find a tangential component of the mechanical variable under consideration on a plane of at least one orientation. It can then be shown that any passage between a shear-free and a sheared state will necessarily exhibit some anisotropic development in time, even if the material itself is of the isotropic kind, that is, shows the same response to mechanical actions in all directions of space when tested in a *ground-state*, where it is at rest and free from externally applied forces. (It follows from symmetry considerations that every shear-free state must be isotropic, and every sheared state anisotropic; and hence, any passage between the states of the two classes must exhibit anisotropic time effects with respect to the mechanical variable which possesses a tangential component.) We shall restrict our attention here to such isotropic materials, subjected to laminar shearing displacements. The laminæ which glide over one another will then suffer tangential and normal components of stress which—according to the theory[1]—must vary simultaneously at differing percentage rates, showing, for example, different exponential indices during an exponential build up, or relaxation. In general, when the tangential component varies as an odd function of time, the normal one must simultaneously vary according to an even function, so that under vibrational displacements in which the former varies with some frequency around a mean value of zero and according to a sine function, the latter must vary simultaneously with double that frequency around a mean value different from zero, and according to a cosine function.

The experiments were actually made on isotropic materials of the visco-elastic type, such as liquid and solid colloids containing rubber, saponified oils, pastes of starch, cellulose acetate, etc., because this type exhibits the anisotropic time effects in an easily accessible range of mechanical actions. (Liquids are understood here as materials which flow under any shearing stress, however small, while solids are capable of maintaining such stresses statically up to a certain limit.) Further, the materials were so selected as to be sensibly incompressible (within the range of applied actions), as this brings about a simplification of the effects here considered.



The accompanying illustration shows on the left-hand side a schematic diagram of the apparatus, and on the right-hand side a typical set of experimental results. The apparatus used was a version of the rheogoniometer[2] specially designed to impose on a material laminar shearing displacements and to measure along various directions in space the development in time of the stresses. The framework of the apparatus consists of a watchmaker's precision lathe with its axis mounted in a vertical position. Concentric with this axis, and secured respectively in the head- and tail-stock of the lathe, are a circular cone (vertex downwards) and a plane circular disk, which touch one another, and form respectively the roof and the base of a horizontal gap of small height, containing the material under examination. One may impose on the material any laminar shearing displacement desired. For this the cone is rotated about its axis but held rigidly against axial translations, while the disk is kept sensibly at rest by constraints against both rotations and axial translations. The wedge-like shape of the gap then ensures that the material suffers the same amount of shear strain in every differential cell of the gap. The apparatus is equipped with measuring devices. For the strains the angle of rotation of the cone is measured and recorded as a function of time, while for the stresses it is necessary to register the action which the material

exercises on the disk. To do this, the constraints of the disk are given the form of elastic cantilevers which yield immediately to the action and thereby measure, and record as functions of time, the *torque* and the *axial force*, that is, the moment about the axis, and the force perpendicular to the plane of the disk. As the yield of the cantilevers changes the dimensions of the gap, it is necessary to prevent these changes from becoming large enough to disturb the time effects significantly, and to use combinations of mechanical and optical lever systems (not shown in the figure) with a sensitivity of about 10^{-6} cm.

The experimental results are conveniently expressed by three graphs in which are plotted, against time, the angular velocity of the cone and the torque and axial force on the disk, each quantity being expressed in percentage of its maximum value. Assume the material to be incompressible, and the motion one of laminar shear throughout the gap. The torque, T, and the axial force, F, are then related to the stress components tangential and normal to the plane of the disk by a purely geometrical factor, and as this factor is independent of time, it cancels out when the percentage values are considered as functions of time. Explicitly, introducing cylindrical co-ordinates, we find that in a differential cell at a point (r, φ, z) the stress, P, has in the plane of the disk the tangential and normal components

$$P_{\varphi z} = P'_{\varphi z} \text{ and } P_{zz} = -P'_{\varphi\varphi} \log R/r,$$

whence integrating over the area of the disk we deduce

$$T = \tfrac{2}{3}\pi R^3 P'_{\varphi z} \text{ and } F = \frac{\pi}{2} R^2 P'_{\varphi\varphi},$$

where the indices attached to P indicate the co-ordinates involved and the dash denotes the value at a point of the rim of the gap ($r = R$).

For such an ideal case the three graphs obtained for the macroscopic development in time must be identical with those obtained in every differential cell of the material for the percentages respectively of the strain velocity, and of the stress components tangential and normal to the plane of the disk. (The height of the gap is chosen sufficiently small to make the forces of inertia negligible under the motions of the material here considered.)

In one type of experiment we used visco-elastic liquids; solids are more troublesome for this type of experiments, since in the build-up period they tend to break under the large strains required, and in the relaxation period show inconveniently slow changes of stress. We were concerned with the time effects encountered in the build-up, and in the relaxation of the various components of stress during periods of stationary rates of laminar shearing displacements. It might appear that during these periods any liquid would run out of the gap. However, in the conditions of shear considered, the visco-elastic liquids used here develop hoop-stresses sufficiently strong to form a cylindrical free boundary, and prevent the running out. At first the material was in its ground-state, and the cone and disk were at rest. Next we started a period of build-up of stress by keeping the disk at rest and suddenly imparting to the cone a rotation with an angular velocity that was maintained throughout the period at a constant level sufficiently high to bring about measurable torques and axial forces on the disk. Finally we proceeded to a period of relaxation of stress by suddenly arresting the motion of the cone and keeping the cone and the disk at rest henceforth. Both periods were covered by a photographic record, and a typical set of results is shown on the right-hand side of the figure in the three graphs. The actions applied to the cone are seen in the graph of the angular velocity, and the anisotropic time effects in the differences between the graphs of the torque and axial force. Interpreting the graphs for every differential cell of the material, we find that the strain velocity is exactly synchronized with the action on the cone, while the stress components are delayed, and show anisotropic time effects, the percentage rates of build-up and relaxation being different as between the components tangential and normal to the plane of the disk.

In a second type of experiment we used visco-elastic materials, both liquid and solid, and proceeded as in the first type, except that the shearing displacement imposed by the rotation of the cone was now varied harmonically in time, with a frequency and amplitude chosen sufficiently high to give measurable torques and axial forces. The results obtained so far showed that, in this case, the torque, and the tangential component of stress, varied around a mean value of zero with the same frequency as the imposed displacement, while the axial force and the normal component varied around a mean value different from zero with twice that frequency. The phase and amplitude relations are still being investigated.

The experiments thus show that anisotropic time effects are produced even in isotropic materials during transitions between shear-free and sheared states, and that in the case of laminar shearing displacements the tangential and normal components of stress conform to the theory, showing simultaneously different times of build-up under a stationary rate of displacement, different times of relaxation under constantly maintained displacement, and different frequencies of vibrations under harmonically varying displacements.

The authors' thanks are due to the Director of Research at the Shirley Institute for the opportunity of performing this work and permission to publish it.

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DIELECTRIC CONSTANT AND PIEZO-ELECTRIC RESONANCE OF BARIUM TITANATE CRYSTALS

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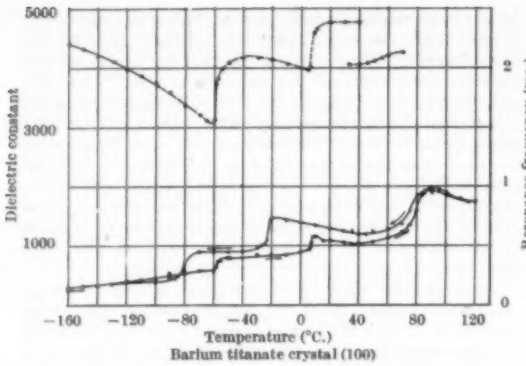
THE growth of barium titanate single crystals and the ferro-electric behaviour of their pseudocubic modification have been described earlier[1,2], and more detailed data can now be given.

There can be obtained at least four modifications of barium titanium compounds, among which the hexagonal and the pseudocubic ones definitely are stoichiometrically $BaTiO_3$[1,2,3]. The dielectric constant of the hexagonal modification is comparatively low, namely, between 100 and 200. The temperature characteristic shows two small peaks near 0° C. and 100° C., at which points maxima of the dielectric constant for the pseudocubic crystals have been found[3].

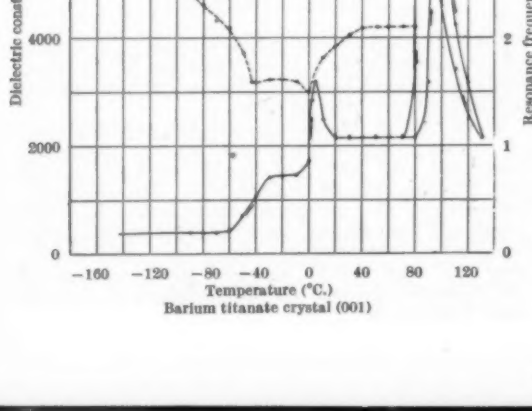


Barium titanate crystal (100)

Crystals of the pseudocubic modification grown from alkali carbonates or barium chloride show a discoloration which ranges from yellow to clear red. Spectroscopic investigation confirmed that this colour is mainly due to dissolved platinum. Colourless crystals were obtained by using carbon crucibles.

The dielectric constant and the piezo-electric resonance frequency have now been measured as a function of temperature, parallel to the three crystallographic directions of the *same* crystal, that is, along its cube edges. The electric field strength was less than 1 volt per cm. at a frequency of 1 kc. The Miller indices on the graphs serve merely to distinguish the three directions in which the electric field was applied to the cube. The crystals usually are twinned with respect to the 011 and $01\bar{1}$ planes[4].

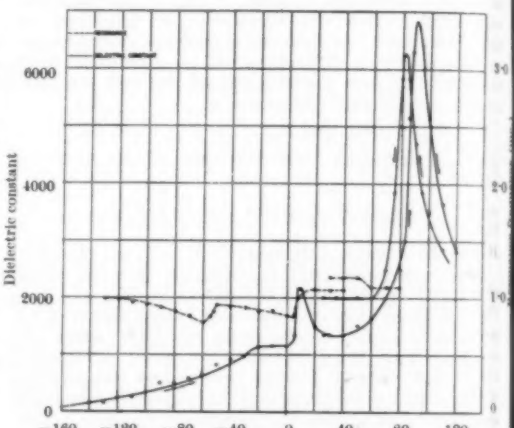
Dielectric hysteresis characteristics have been observed in all three directions and show that the hysteresis disappears only above 100° C. (Slight deviations in temperature from values observed by other authors are probably due to impurities.) Therefore, this temperature represents the only Curie point in contrast to the peaks around 5° C. and −70° C., as already shown in previous measurements[2,3,5]. The course of the piezo-electric resonance indicates some kind of a transition at these temperatures[5], but more investigation is necessary to reveal its nature.



Barium titanate crystal (001)

The thermal hysteresis is considerable and has to be attributed to the existence of large (about 1-2 mm.) spontaneously polarized domains, which are easily visible[7].

From the crystallographic point of view, the present situation is different from that of Rochelle salt or the di-hydrogenphosphates in that barium titanate is a new type of ferro-electric in which all the three crystallographic axes seem to show a similar behaviour. The twinning might give some erroneous results for the absolute value of the dielectric constant; but as microscopic observations with a heating stage show, the twinning should only affect the 010 and 001 results, since here the different axes might overlap one another. That there is virtually no twinning perpendicular to 100 confirms the fact that the ferro-electric behaviour of barium titanate is much less anisotropic than that of the above-named salts, and much more similar to the ferro-magnetics. Considerable progress has been made in obtaining untwinned crystals, and more conclusive results will be given shortly[7].



Barium titanate crystal (010)

Whether the crystals in the Curie range really are tetragonal seems doubtful. Observations with polarized light, made by Prof. Fairbairn of this Institute, give no evidence whatsoever for a tetragonal structure, but point to optical biaxiality. More complete optical data would be desirable and will be obtained when larger unstrained crystal sections become available.

From the dielectric and piezo-electric behaviour of single crystals given above, the peculiar piezo-electric property of barium titanate ceramics[8] may be perhaps interpreted similarly to the quadratic magnetostrictive effects in polycrystalline iron.

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[6] von Hippel, A., Breckenridge, R. G., Chesley, F. G., and Tisza, Laszlo, *Ind. and Eng. Chem.*, **38**, 1097 (November 1946).

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EXPLORATION OF THE LLOYD GEORGE MOUNTAINS IN THE NORTHERN CANADIAN ROCKIES

By Dr. N. E. ODELL

AN Anglo-Canadian-American expedition, sponsored by F. S. Smyth, and consisting of seven members, was able during the past summer (1947) to carry out the exploration of the Lloyd George Mountains, which are situated in northern British Columbia. This mountain group lies just south of lat. 58° N., and only the foothill district to the south of it had previously been visited. The name Lloyd George Mountains, in honour of the late British premier, was given in 1916 by P. L. Haworth, who made a difficult journey to the lake, now named after him. It was Haworth Lake, fed by the melt-waters draining the Lloyd George Icefield, which was utilized by this year's expedition as a base.

We were an airborne expedition, and flew in a sea-plane in two parties, from a take-off some 250 miles to the southward. A reconnaissance flight was made from Haworth Lake (altitude *c.* 3,800 ft.) before the departure of the aircraft, and this revealed a vast snowy range lying to the north-west as well as the south-east of the contiguous Lloyd George Group. It is a highly complicated and deeply dissected mountain region, with the highest peaks approaching 10,000 ft. in elevation. The eastward flowing Liard River, bounding this belt of mountains on the north, would seem to form the true northern limit of the Rocky Mountains proper, as originally suggested by R. G. McConnell and again recently by M. Y. Willams[1].

The dominating physiographic feature, from which rise the highest peaks, all of which were ascended, is the Lloyd George Icefield, and its main *névé* covers some 45 sq. miles, but with dependent glaciers it is 90–100 sq. miles in total extent. Steep glaciers descend to an altitude of 4,000 ft. in heavily forested valleys, which are the haunt of bear, deer and other game. A very rich and beautiful alpine flora was found, particularly in July, up to an elevation of 7,000 ft. and more. More than two hundred species were collected, some believed new, and these were sent for determination to the Royal Botanic Garden, Edinburgh. The flora was quite as profuse as hundreds of miles farther south in the Canadian Rockies.

As to the solid geology, the district explored lies entirely eastward of the Rocky Mountain Trench, that great structural feature which separates the Rocky Mountains proper from the diverse ranges of the central portions of British Columbia. The latter region is underlain by sedimentary and volcanic rocks of Palæozoic and Mesozoic age, with immense batholithic intrusions, ranging in age from pre-Carboniferous to Tertiary, and considered to have been the source of the metallic mineral deposits of central British Columbia.

In contrast, the ranges of the Rocky Mountains eastward of the Great Trench are a series of highly folded sediments with representatives of practically the whole geological succession, but without eruptive rocks, and devoid of ore deposits.

The Lloyd George Mountains are carved out of a great thickness of Palæozoic rocks, which are overfolded towards the east and often display in individual peaks the characteristic tilted fault-block type of structure and so-called 'writing desk' form, so prevalent elsewhere in the Canadian Rockies. Mainly composed of hard limestones, the softer interbedded shales and slates, with the softer limestone, are normally highly folded and sheared. No extensive overthrust masses (*nappes de recouvrement*) were observed. Compression and shear have been responsible for the destruction of almost all organic remains, and only in one locality high up in a mountain face was found a fossil coral horizon which appears to be of Silurian age. The field collection made by me has yet to be worked out.

Regarding the glacial geology, an outstanding discovery was a large stagnant glacier, lying in a deep canyon-like valley, which was entirely blanketed in moraine, and upon which trees and plants were growing. This glacier, extending through a range of altitudes of from 4,500 to 6,000 ft., appears to be the only one of its kind which is known south of Alaska.

The glaciers of the region generally appear to be in a state of slow recession. The present summer snow-line lies at approximately 7,900 ft.

The survey, and other scientific work of the Expedition, was greatly hampered by the prevailing bad weather, which, throughout the Rockies during the summer of 1947, was the worst on record for forty or more years.

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CAMBRIDGE ARCHÆOLOGICAL EXPEDITION TO CYRENAICA

By C. B. M. McBURNEY, R. W. HEY and W. WATSON

THE first Cambridge Archæological Expedition to Cyrenaica, North Africa, took place during the summer of 1947. A total of three months was spent in the field, and the following were the principal results obtained.

The primary object of the expedition was to investigate the Palæolithic succession in the coastal area, and to correlate it, if possible, with any traces that might be found of a marine Pleistocene succession. Italian geological literature of the pre-war period mentions the presence of marine Pleistocene deposits in the Benghazi plain, and refers to probable Pleistocene shore-lines at several points along the Cyrenaican coast. So far as we know, however, no detailed study of these was ever undertaken.

Accordingly, the first part of our time was spent in an examination of the more accessible portions of the coast between Benghazi and Derna, in order to locate beach conglomerates, wave-cut terraces and other traces of high level shore-lines. These were discovered in fair abundance, though obscured in many places by masses of alluvial material. From the results obtained by levelling such features, it is hoped to establish the Pleistocene succession of sea-levels for this part of the coast. The highest shore-line of which traces were found was at some 80 metres, in the Derna region ; the lowest lay at about 6 metres and was preserved in most of the areas examined. The intermediate levels are still under consideration.

The cultural succession associated with these events proved most instructive. Traces of the Middle Palæolithic could be recognized at various points along the coast, and a few specimens embedded in the beach conglomerates can probably also be attributed to the same stage. A rich Levallois station was discovered five miles west of Derna and can almost certainly be associated with the terra rossa at 5 metres above sea-level.

On the other hand, an evolved Mousterian industry occurred in a silt deposit in a tributary of the Wadi Derna, associated with a vertebrate fauna and well-preserved plant remains. This deposit interdigitates with the high terrace of the Wadi Derna, which was surveyed down-stream to a point about three-quarters of a mile from the sea. There is no doubt that this terrace was formed in connexion with a sea-level much higher than the present, though further work will be necessary before an exact estimate of the height of this level can be given.

No traces earlier than blade industries of Upper Palæolithic or later date occur on the consolidated dunes which line the modern shore, and which presumably belong to the low sea-level of the last glaciation.

Detailed information regarding the form and associated fauna of at least one phase of these later industries was obtained from a cave discovered and excavated in the Wadi Cuf, fifteen miles from the coast. The two faunas, and the flora from the Wadi Derna, should provide considerable information on the Pleistocene climatic sequence of the east Libyan seaboard.

We should like to express our gratitude for the assistance afforded by King's College, Cambridge, and the British Museum, in defraying the expenses of two of the members of the expedition, and particularly to the Trustees of the Percy Sladen Memorial Fund for their generous grant, without which the expedition would never have been undertaken. The constant help and co-operation of the authorities of the British Military Administration of Cyrenaica was also an important factor in the success of the expedition.

A further visit in the near future, to amplify and complete these findings, is planned.

THE COMMON COLD

THE Cantor Lecture before the Royal Society of Arts, delivered on January 20 by Dr. C. H. Andrewes, of the National Institute for Medical Research, is an admirable summary of the essential features of our knowledge of that world-wide scourge, the common cold; and nobody is better fitted than Dr. Andrewes to state what we know and what we do not know about it. This problem is being attacked energetically by a research unit of the Medical Research Council in a hospital built at Salisbury during the War by Harvard Medical School and the American Red Cross, and eventually presented to the Ministry of Health.

If, as Dr. Andrewes showed, those who are working on this problem in Great Britain and other countries are only beginning to pick up clues to the solution of what is one of the most complex problems of virology, there is plenty of evidence that this relative ignorance will not persist for very long. All the portents, indeed, suggest that presently the common cold, like typhus, typhoid, cholera, smallpox, yellow fever and other plagues, will have yielded to human domination. But this will not come about without much patient research and, when that research has found the methods of control and cure, the co-operation of the public will be required. For, as Dr. Andrewes explained, the common cold, or more accurately, perhaps, the various varieties of it which probably exist, depend very much for their dissemination upon such human habits as sneezing, coughing, handkerchief-waving and so on—all of them habits which people will not readily alter to the degree that scientific control of infection requires.

The work of the Air-Hygiene Unit, the members of which are collaborating more and more closely with the workers on the common cold, demonstrates the importance of this aspect of the problem. It has been shown, for example, that handkerchiefs shaken in the air can disseminate very many bacteria, and other work suggests that impregnation of handkerchiefs with certain substances, among which phenyl mercuric bromide is promising, may make them less dangerous. Possibly the handling of infected handkerchiefs, rather than waving them about, may be an even more important means of dissemination of the organisms concerned.

Research on the common cold, like all work on diseases caused by viruses, was hampered until methods of cultivating viruses in the laboratory were discovered. Now that these are available, it is possible to use, for work on the common cold, the method of cultivation of viruses which has been more successful than any other, namely, their cultivation on the fertile hen's egg. American workers have claimed that they have successfully grown the 'cold' virus in hen's eggs; Dr. Andrewes and his colleagues, who are attacking the whole problem in Britain, have used the same techniques, but have so far been unable to confirm the American results. Dr. Andrewes discussed this point and suggested that probably the two groups of workers are studying colds due to different causes, the American type of cold being more like the condition known as sinusitis, whereas the British workers are studying the runny-nose type. Thus one of the important requirements is successful isolation and cultivation in the laboratory of the viruses concerned, of which there may be several.

Another great handicap in this work is the lack of a suitable experimental animal. The virus of human influenza will 'take' in ferrets, but the chimpanzee is the only animal so far known to be susceptible to the human common cold; and chimpanzees are expensive and difficult to handle. Human volunteers must therefore be used, and in his lecture Dr. Andrewes described the work being done at Salisbury where the Medical Research Council Unit has so far had the help of five hundred human volunteers. A sound technique has now been evolved; methods of storing and filtering the virus have been worked out; it has been shown that the incubation period of the colds studied was two to three days, and that the nasal secretions will not communicate a cold if they are diluted beyond 1 in 100. Bacteria-free filtrates of nasal washings from volunteers with colds have produced colds in about 50 per cent of subjects, and this has happened all the year round, with possibly a lower percentage of colds acquired during the winter.

This last point will surprise those who believe that cold and wet precipitate, or even cause, colds; but Dr. Andrewes made wise and salutary comments on this view in the section of his lecture devoted to the effect of the season and the weather, and in the interesting section on the incidence of colds in the Arctic and in Spitsbergen, where the outbreak of colds is intimately connected with the arrival and departure of ships from the outside world. This part of the lecture and also Dr. Andrewes' remarks on the value of the many cold cures that are constantly recommended should certainly be read by the "scores, perhaps hundreds" of people who have

written to the Salisbury Unit to tell them how to solve this difficult problem.

Men of science will appreciate this lecture as an example of how to handle an intricate subject with a charm and simplicity of phrase which make it readily intelligible to everybody. G. LAPAGE

BRITISH ROCKET WEAPONS RESEARCH

THERE is nobody better qualified to discuss our war-time development of rocket weapons than Sir Alwyn Crow, and it would therefore be unprofitable to attempt to dispute the clear statement of facts which he presented as the thirty-fourth Thomas Hawksley Lecture at the Institution of Mechanical Engineers on November 21, 1947, his subject being 'The Rocket as a Weapon of War in the British Forces".

Sir Alwyn first traced the development begun in 1935 of the three main types of motor which formed the basis of almost all British rocket-propelled weapons. These were steel tubes of 2 in., 3 in. and 5 in. diameter containing a solid cordite propellant charge, which was ignited at the front, the gases being discharged in each case through a single nozzle at the rear. Pointing out that from the military point of view one of the greatest advantages of the rocket propulsion of missiles is the absence of recoil forces on the projector, Sir Alwyn went on to describe how these motors were combined with different types of explosive head and projection apparatus to meet such varied demands as for anti-aircraft fire, barrage weapons for mass bombardment and airborne projectiles for land and sea targets. He also described the development of rocket motors of the high degree of reliability necessary to provide the extra thrust which enabled aircraft to take off with a much shorter run. An idea of what was achieved in these fields may be gathered from the fact that "a single craft was able to fire highly lethal ammunition on the chosen target area at the rate of half a ton a minute for nearly a minute at a time", and the hitting power of a single aircraft was "momentarily the equivalent of the full firing power of a medium cruiser".

As this was his main concern, Sir Alwyn's paper dealt primarily with the detailed development of solid-fuelled rockets to meet a number of specific requirements; but since there can be little doubt that British progress in the field of rocket development at the end of the War was some ten years behind that of the Germans, it would be interesting if Sir Alwyn could be persuaded to present his views on a number of the other aspects of this type of armament, aspects which must have been the subject of much discussion because of their fundamental nature. Were difficulties of production and the impossibility of making the necessary research in the early stages the obstacles that precluded the use of liquid fuels, with the enhanced index of performance which would be expected from them? Why was so much greater emphasis placed on fin stabilization than on spin stabilization? Was progress made in the examination of methods of control and guidance of the projectile during its flight, or was it considered in Britain that the inherent advantages of the unguided weapon outweighed any which might accrue from guidance? Even our choice of solid propellants appears to have been very limited, and it would be interesting to know what attempts were made to develop other types. The use of light alloy tubing for the motor body would seem to be an obvious way to increase the charge/weight ratio, and the steps made to investigate its possibilities would be worth knowing.

The only fair criticism which can perhaps be made of Sir Alwyn's lecture is that he made no mention of the aiming and sighting equipment developed to ensure that the projectiles would arrive at the right spot at the right moment, for if they fail to do this all the ingenuity lavished on the design of the weapon is useless. R. H. MACMILLAN

PHOTO-ELASTICITY IN MECHANICAL ENGINEERING

TWO papers which make a very useful addition to the sparse literature on photo-elasticity were presented to the Institution of Mechanical Engineers on December 12, 1947. Mr. W. A. P. Fisher's paper dealt with the basic physical properties of model materials which are relied upon in the 'frozen stress' technique of three-dimensional stress analysis. This technique, which was originated in Germany and the United States, is based on the fact that certain photo-elastic model materials have a very low Young's modulus at elevated temperatures and consequently suffer considerable deformations under small loads. If such small loads remain in position during subsequent cooling, it is found that the materials set in the strained position and retain, after the removal of the loads, virtually the whole of the strain and the photo-elastic effect associated with the loading at the elevated temperature; hence the term 'frozen stress'. This phenomenon is utilized in three-dimensional analysis by cutting thin slices from a three-dimensional model, which can then be examined in a photo-elastic polariscope in accordance with the ordinary two-dimensional technique. The 'frozen stress' patterns are not found to be appreciably disturbed by careful cutting.

The major part of Mr. Fisher's paper was devoted to a discussion of the suitability of phenol-formaldehyde resins, particularly 'Catalin 800', for use with this technique. In the United States, glyptal resins have been used for this purpose almost without exception; but as this material is very expensive and difficult to obtain in Britain, considerable interest is attached to the detailed investigation of the merits of 'Catalin' which was carried out at the Royal Aircraft Establishment, Farnborough, by Mr. Fisher. Data were given in the paper of the physical properties of 'Catalin', both at room temperature and at its softening temperature. Young's modulus at 80° C. appears to be about 1/120 of the value at room temperature. The paper also contained some practical illustrations of the 'freezing' technique.

Mr. R. B. Heywood's paper on "Some Modern Applications of Photo-elasticity" contained a brief outline of photo-elastic theory and a summary of the properties of the more important model materials, followed by some interesting examples of applications to design problems taken from the field of mechanical engineering.

It will be an encouragement to everyone interested in photo-elasticity that the engineering institutions are once more, after a long interval, taking an interest in this valuable method of stress analysis.

E. K. FRANKL

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 1

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Prof. G. E. Blackman: "Oil as a Farm Crop".

CHEMICAL SOCIETY, BIRMINGHAM SECTION (in the Chemistry Lecture Theatre, The University, Birmingham), at 4.30 p.m.—Prof. C. K. Ingold, F.R.S.: "Steric Hindrance".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 4.30 p.m.—Prof. Eric K. Rideal, F.R.S.: "Colloids". (Further lectures on March 8 and 15.) (Cantor Lectures.)

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON SECTION of the INSTITUTE OF METALS, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. C. J. P. Ball: "The Manufacture and Usage of Magnesium and its Alloys".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Central Library, Hempstead Road, Watford), at 7.30 p.m.—Dr. F. Wokes: "Nutrition in relation to Post-War Problems". (To be repeated on Saturday, March 20, at 3 p.m., at the South-East Essex Technical College, Longbridge Road, Dagenham.)

Tuesday, March 2

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. Z. Young, F.R.S.: "The Brain and its Functions".*

CHEMICAL SOCIETY, LEEDS SECTION (joint meeting with the LEEDS UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Leeds), at 5 p.m.—Film Display of Scientific Films; at 6.30 p.m.—Prof. J. A. V. Butler: "The Protein Molecule and its Degradation by Enzymes".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. Roger Duff: "Digging up the Moa Hunters—an Earlier Phase of Maori Culture".

UNIVERSITY COLLEGE LONDON (in the Physiology Theatre, Gower Street, London, W.C.1), at 5 p.m.—Dr. L. E. Bayliss: "Some Aspects of General Physiology". (Further Lectures on March 9, 16 and 23.)*

KING'S COLLEGE (Strand, London, W.C.2), at 5.30 p.m.—Prof. C. A. Coulson: "Quantum Theory in Physics and Chemistry". (Inaugural Lecture in the Chair of Theoretical Physics.)*

CHEMICAL SOCIETY, DUBLIN SECTION (at University College, Dublin), at 7.30 p.m.—Sir Ian Heilbron, F.R.S.: "Recent Developments in the Vitamin A Field" (Fedler Lecture).

Wednesday, March 3

MANCHESTER METALLURGICAL SOCIETY (at the Engineers Club, Albert Square, Manchester), at 6.30 p.m.—Mr. E. Mills: "Metallurgical Problems arising from the Use of Non-Ferrous Metals in the Telecommunication Industry".

INSTITUTE OF WELDING, MANCHESTER AND DISTRICT BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. E. McMinn: "Welded Tubular Structures".

Thursday, March 4

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. S. E. Hollingworth: "Geology—a Preliminary to Planning".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "Calculating Machines" (to be opened by Prof. M. H. A. Newman, F.R.S.).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S.: "Current Research Work in the Cavendish Laboratory". (Further Lectures on March 11 and 18.)

KING'S COLLEGE (Strand, London, W.C.2), at 5.30 p.m.—Prof. S. W. Wooldridge: "The Role and Relations of Geomorphology". (Inaugural Lecture in the Chair of Geography.)*

INSTITUTE OF PETROLEUM, LONDON BRANCH (at Manson House, 26 Portland Place, London, W.1), at 6 p.m.—Inaugural Meeting; Mr. J. A. Oriel: "Petroleum in the Modern World".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (at the College of Technology, Manchester), at 7.15 p.m.—Dr. R. M. Ruhemann: "The Measurement of Low Temperatures".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. E. L. Hirst, F.R.S.: "The Occurrence and Significance of the Pentose Sugars in Nature, and their Relationship to the Hexoses" (Hugo Müller Lecture).

Friday, March 5

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting; Dr. G. M. Bennett, F.R.S.: "The Proximate Analysis of Mixtures by Methods depending on Differential Solubility and Saturation".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. Butterworth: "Development and Use of Magnetic Apparatus for Bomb and Mine Location"; Mr. B. Roston: "Development of Locators of Small Metallic Bodies Buried in the Ground".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. W. Muckle: "Resistance to Buckling of Light Alloy Plates"; Dr. E. G. Richardson: "Measurement of Water Movements Associated with Ships".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. Arne Tiselius: "Some Recent Advances in Adsorption Analysis".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Edward Salisbury, F.R.S.: "Flowers of Spring".

CHEMICAL SOCIETY (joint meeting with the UNIVERSITY COLLEGE OF SWANSEA STUDENTS' CHEMICAL SOCIETY, at University College, Swansea).—Prof. F. S. Spring: "The Antibacterial Compound, Aspergillic Acid".

Saturday, March 6

INSTITUTE OF ECONOMIC ENGINEERING, MIDLAND REGION (at the Chamber of Commerce, Birmingham), at 2.30 p.m.—Mr. D. R. Burrows: "Rubber and its Manufacture".

SCHOOL NATURE STUDY UNION (at the City Literary Institute, Stukeley Street, Drury Lane, London, W.C.2), at 2.30 p.m.—42nd Annual Conference; at 3 p.m.—Prof. S. W. Wooldridge: "Geology and the Study of Natural Environment".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. A. Baltz: "Ladakh and the Dances at Hemis Monastery".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT EXPERIMENTAL OFFICERS (2) in a team which is to carry out research work on insecticides at Porton for the Colonial Insecticides Committee—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (March 8).

ASSISTANT CURATOR at the Royal Botanic Gardens, Kew—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2113 (March 12).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, The University, Sheffield (March 13).

ASSISTANT LECTURER IN PHILOSOPHY—The Registrar, The University, Manchester (March 13).

RESEARCH WORKER (temporary) IN THE DEPARTMENT OF ANIMAL HEALTH—The Registrar, University College of Wales, Aberystwyth (March 14).

ANALYTICAL CHEMIST IN THE DEPARTMENT OF GEOLOGICAL SURVEY, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 15).

LECTURERS IN MATHEMATICS (pure or applied)—The Registrar, King's College, Newcastle-upon-Tyne (March 15).

CHEMIST-IN-CHARGE (temporary) at the Royal Ordnance Factory, Birtley, Co. Durham, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.135/48A (March 16).

CHEMIST-IN-CHARGE (temporary) at the Royal Ordnance Factory, Nottingham, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 669, York House, Kingsway, London, W.C.2, quoting F.413/48A (March 16).

PRINCIPAL LECTURERS, SENIOR LECTURERS, and LECTURERS, IN MECHANICS, MACHINES, MATERIALS AND STRUCTURES, HEAT ENGINES, ELECTRICAL ENGINEERING, and TELECOMMUNICATIONS, at the Military College of Science, Shrivenham, Swindon—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2119 (March 22).

METEOROLOGISTS (2) as Professional Assistants in the Royal Observatory in Hong Kong—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (March 22).

TOBACCO OFFICERS (General) and TOBACCO OFFICERS (Special) in the Professional Officers' Grade in the Tobacco Branch of the Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 26).

ASSISTANT DIRECTOR OF NATIVE AGRICULTURE to the Government of Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (March 26).

UNIVERSITY DEMONSTRATOR IN PHYSICS, and a UNIVERSITY LECTURER IN PHYSICS—The Secretary, Appointments Committee of the Faculty of Physics and Chemistry, Chemical Laboratory, Pembroke Street, Cambridge (March 31).

ASSISTANT PROFESSOR OF MINING ENGINEERING at Fouad I University, Giza, Egypt—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (March 31).

JUNIOR CHEMISTS (female) for service in Tanganyika Territory in connexion with a Fertilizer Research Scheme—The Under-Secretary of State, Research Department, Colonial Office, Palace Chambers, Bridge Street, London, S.W.1 (April 3).

LECTURER IN PSYCHOLOGY (including Experimental Psychology)—The Secretary, The University, Aberdeen (April 15).

ASSISTANT LECTURERS or LECTURERS IN (*a*) PURE MATHEMATICS, (*b*) APPLIED MATHEMATICS, and (*c*) STATISTICS—The Registrar, The University, Leeds 2 (April 17).

PLANT BREEDERS (2), primarily for cereals—The Secretary, School of Agriculture, Cambridge (April 30).

ENTOMOLOGIST IN THE MEDICAL DEPARTMENT (Yellow Fever Research Institute), Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1.

RESEARCH ASSISTANT (male) IN THE MECHANICAL WORKING DIVISION—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Mechanical Working Division'.

RESEARCH ASSISTANT to work on new biological methods of hormone assay—Prof. N. F. Maclagan, Westminster Hospital Medical School, 17 Horseferry Road, London, S.W.1.

TECHNICIAN IN THE DEPARTMENT OF ANATOMY—The Secretary, University College London, Gower Street, London, W.C.1, quoting "Anatomy/1".